INTRODUCTION

The results of work at Olduvai prior to 1960 have been described in the two volumes by L. S. B. Leakey published in 1951 and 1965 respectively. They will, therefore, not be further discussed here, except in connection with the cultural material obtained from Beds I and II.

Following the discovery of the cranium of *Australopithecus* (*Zinjanthropus*) *boisei* in 1959, funds made available to us by the National Geographic Society, Washington D.C., enabled systematic excavations to be carried out over a period of two and a half years. At the beginning of the first season, in 1960, extensive excavations were undertaken at site FLK, in a search for further parts of '*Zinjanthropus*'. Although largely unsuccessful in this respect, a remarkably clear distribution pattern of an Oldowan living floor was revealed, one that has proved to be the most complete and extensive of any subsequently uncovered. During the same year site FLK NN yielded the remains of *Homo habilis* on part of another Oldowan living floor. FLK North, at the top of Bed I, and DK, at the base of Bed I, were also partly explored.

(Bed I has now been divided into two parts by R. L. Hay, namely an Upper and a Lower Member, separated by the basalt which was formerly considered as the base of Bed I. For the sake of brevity, and since the material discussed in this report was obtained solely from the Upper Member, this will still be referred to as Bed I. When any reference is made to the Lower Member this will be specifically stated.)

At the start of the season in 1962 further excavations were carried out at FLK North and DK where a stone structure had been found. The main objective, however, was a systematic exploration of Bed II. At that time there was still no satisfactory stratigraphic correlation between the important Bed II sites in the Side Gorge, such as BK and SHK, with those in the Main Gorge (EF–HR, TK, etc.). In fact, it was not until work had closed down and laboratory analysis of various deposits had been completed by R. L. Hay that certain marker tuffs in the Side Gorge could be correlated with tuffs in the eastern part of the Gorge.

Sites in Bed II were selected for excavation as far as possible in stratigraphic sequence, beginning with HWK East, at the base, and working up to BK, the highest known occupation level in the bed. In all, nine sites in Bed II were explored in detail, in addition to the four in Bed I. The relationship of the cultural material from the excavated sites to the sequence published in 1951 is discussed in chapter X, but it may be stated here that no evidence was found to indicate a direct evolution of bifaces from the Oldowan choppers. A different picture has emerged which is still not entirely clear. This is hardly surprising if the time span covered by the Olduvai deposits is considered, as well as the geographic area involved. It has also become evident that the earliest known industry from Olduvai, that from DK, already represents a stage of development in which a multiple tool-kit was in use, indicating the pre-existence of more primitive and less organised stages of tool-making.[1]

The cultural material from Bed I and the base of Bed II can be referred to the Oldowan and remains virtually unchanged from the base of the Upper Member of Bed I to the lowest part of Bed II. It is characterised by choppers of various forms, polyhedrons, discoids, scrapers, occasional subspheroids and burins, together with hammerstones, utilised cobbles and light-duty utilised flakes. In Bed II there is evidence for the existence of two industrial complexes whose contemporaneity, in the broad sense, has been confirmed at a number of different sites. One is clearly derived from the Oldowan and has been termed Developed Oldo-

[1] Artefacts that can be dated at approximately 2·6 million years have since been found at Koobi Fora, on the east side of Lake Rudolf, in Kenya (Leakey, M.D., 1970*a*).

wan, while the second must be considered as a primitive Acheulean. In the Developed Oldowan A from Lower Bed II Oldowan tool forms persist, but there is a marked increase in spheroids and subspheroids and in the number and variety of light-duty tools. In the upper part of Middle Bed II and in Upper Bed II a few bifaces are also found in Developed Oldowan assemblages, but they form such a negligible proportion of the tools that it has been considered unjustifiable to assign this industry to the Acheulean. It has, therefore, been termed Developed Oldowan B, to distinguish it from the preceding phase (A) which does not include bifaces. Sites where bifaces amount to 40 per cent or more of the tools have been classed as Acheulean. They are known principally from the eastern part of the Gorge, where they occur in the upper part of Middle Bed II. They are, therefore, both contemporary with, and earlier than, Developed Oldowan B sites in Upper and Middle Bed II. The Acheulean appears to be an early form in which the bifaces exhibit minimal flaking and considerable individual variation. They form a high proportion of the tool assemblage, however, and include irregular ovates, oblong picks and a cleaver.

The method of presentation of the material in this volume has posed many problems. A purely stratigraphic approach has finally been considered most satisfactory. The descriptions of the excavated sites and the lithic industries have, therefore, been divided into six groups, based on stratigraphic units demarcated by Marker Tuffs. These are as follows: Lower Bed I, below Tuff I^B; Middle Bed I, between Tuffs I^B and I^D; Upper Bed I and Lower Bed II, between Tuffs I^D and II^A; the lower part of Middle Bed II, between Tuffs II^A and II^B; the upper part of Middle Bed II, between Tuffs II^B and II^C and Upper Bed II above Tuff II^C, as in Table 1.

In previous publications the site names have been followed by the number of the bed in which they occur, i.e. FLK I, BK II, etc. For the present volume the designations of beds have generally been omitted as being needlessly repetitive, since the subdivision of the text on a stratigraphic basis indicates the level at which any particular site occurs.

The material from the different stratigraphic units and from the various sites is described in ascending order, i.e. the earliest is described first. When deposits exposed in sections are listed, however, they are given in the order in which they occur, with the lowest at the bottom. The material from each level has been considered separately when preliminary analysis indicated that this was desirable but, where close similarity was found to exist between assemblages from adjacent levels, they have been pooled and treated as a single series.

Selecting specimens for illustration has also proved difficult. It is clearly impracticable to illustrate on the basis of proportionate representation, although theoretically this would be the ideal method. New elements, as they appear, must necessarily be given prominence and there is a tendency for these to overshadow the familiar tool types which are numerically greater. This applies particularly to the small tools in the Developed Oldowan and to the bifaces in both the early Acheulean and the Developed Oldowan B. In order to overcome this difficulty diagrammatic representations of the more common tools have been included. These, it is hoped, will convey an impression of their relative abundance. Information regarding the proportions of the various elements in the industries is given in the histograms in Fig. 117 and these should be referred to in connection with the illustrations of tools.

In the case of the faunal material from the occupation sites, only a preliminary study has been possible in the time available. This does not include taxonomic identifications or an estimate of the numbers of animals represented. An indication of the proportionate occurrence of the larger mammals and reptiles at different sites has, however, been obtained by counting the number of specimens which can be unquestionably assigned to these taxa. A complete list of all identified faunal material from Beds I and II for which the stratigraphic positions are well authenticated is also given in Appendix B.

Table 1. *The stratigraphic positions of the hominid remains and of the Oldowan, Developed Oldowan and Early Acheulean sites in Beds I and II in relation to the Marker Tuffs*

		Marker tuffs	Hominid remains	Sites	Cultural facies
Bed II	Upper	II^{D}	H. 3	BK (66)	Developed Oldowan B
			H. 9 (LLK)	TK (19)	Developed Oldowan B
		II^{C}			
	Middle	II^{B}	H. 19	SHK (68)	Developed Oldowan B
				MNK Main Site (71)	Developed Oldowan B
				FC West (62)	Developed Oldowan B
				CK (27*a*)	Probably Early Acheulean
				Elephant K (55)	Probably Early Acheulean
				EF–HR (23)	Early Acheulean
			H. 13, 14, 15	MNK Skull Site (71)	Oldowan
				FLK North, Sandy Conglomerate (40)	Developed Oldowan A
				HWK East, Sandy Conglomerate (48)	Developed Oldowan A
		II^{A}			
	Lower		H. 16 (Maiko Gully)	FLK North, *Deinotherium* Level	Indeterminate
				FLK North, clay with root casts	Indeterminate
				HWK East, Level 2	Indeterminate
		I^{F}			
Bed I (Upper Member)	Upper		H. 10	FLK North, Levels 1–6	Oldowan
		I^{D}			
	Middle			FLK, upper Levels (41)	Indeterminate
			H. 5, 6	FLK, the '*Zinjanthropus*' Floor	Oldowan
			H. 7, 8	FLK NN, Levels 1, 2, 3 (38)	Oldowan
		I^{B}			
	Lower		H. 24	DK, Levels 1, 2, 3 (22)	Oldowan
			H. 4 (MK)	FLK NN, Level 4	Indeterminate

DEFINITION OF TERMS

The terminology employed in the preliminary paper on Beds I and II prepared for the symposium on the 'Systematic investigation of the African later Tertiary and Quaternary' held at Burg Wartenstein in 1965 (M. D. Leakey, 1967) has been retained in the present report, with certain minor alterations which became necessary when the entire collection of material had been examined.

The term 'proto' is now omitted when referring to burins, since these tools are, in fact, entirely typical, although some of the Bed I examples are of larger size than is usual in later industries. 'Hand-axe' has been dropped in favour of the more non-committal term 'biface' since this can be applied to specimens of any size, including the diminutive examples found in the later stages of the Developed Oldowan. Among the choppers, the only alteration has been in the series formerly termed 'bilateral'. These are now described as 'two-edged', since in some examples from Bed II the cutting edges are variously placed and are not necessarily situated on either side.

The division of the cultural material into three main groups, i.e. tools, utilised material and *débitage* has been retained. Natural stones introduced to the sites by hominids are termed 'manu-

ports', but are not included in the analyses since they lack evidence of modification.

The majority of the tools and utilised material can readily be separated into heavy- and light-duty groups, but, in order to avoid any ambiguity, specimens with a mean diameter exceeding 50 mm. have been termed *heavy-duty*, and those of 50 mm. or less *light-duty*. Except in the case of spheroids and subspheroids, which are almost entirely made from quartz or quartzite, weights have not been recorded since they vary according to the type of raw material and the extent of weathering. In place of weight, the mean diameter $\frac{1}{3}$(length + breadth + thickness) has been recorded for the majority of the heavy-duty tools since this provides a fair indication of overall size. (One series of choppers, in which the average mean diameter is 74 mm. and which is made up of approximately 50 per cent lava and 50 per cent quartz and quartzite, was weighed experimentally and gave an average weight of 1 lb. 6 oz. for each specimen). The ratio of working edge to the circumference has also been noted for side and end choppers, since, if either of these forms eventually gave rise to bifaces, the ratio of the working edge might be expected to be greater in the more evolved assemblages. This has not proved to be the case, and the only significant fact established is that choppers made on blocks of material, such as quartz or quartzite, tend to have a higher edge ratio than those made on cobbles.

The revised terminology used in the present volume for the Oldowan, Developed Oldowan and Acheulean is as follows:—

TOOLS

1. *Choppers*

These are usually made on cobblestones with rounded cortex surface forming the butt ends. When they are made from blocks of quartz or quartzite (particularly in Upper Bed II) the butts are often formed by a flat vertical surface, trimmed and blunted along the upper and lower edges. In the majority the trimming is bifacial, with multi-directional flaking of the working edges. These are essentially jagged and lack secondary trimming, although utilisation has often resulted in the edges having been chipped and blunted. In some examples, particularly in the cobble-choppers from Bed I, the butts have also been used as hammer-stones and are extensively pitted and bruised. It is possible to distinguish five types of choppers:

(*a*) *Side*. The maximum diameter is bilateral, exceeding the length from the working edge to the butt; often made on oblong cobbles with the working edge along one lateral edge. Bifacial examples with alternate flaking predominate but there are also a few unifacial specimens and some in which there is multiple flaking on one face of the working edge and a single scar on the obverse. Side choppers are by far the most common type and amount to 64·6 per cent of all the choppers recovered from Beds I and II.

(*b*) *End*. The maximum length is from the working edge to the butt; they are usually made on oblong cobblestones with the working edge at one extremity. Unifacial examples are rare. After side choppers they are the most numerous category and amount to 21·9 per cent of the total number of choppers.

(*c*) *Two-edged*. Two bifacially flaked working edges are present. Specimens from Bed I are generally oblong and blunt-ended, with a working edge on either side, but those from Middle and Upper Bed II include a number in which the working edges are at either end or at one end and on one lateral edge. Two-edged choppers amount to 8·4 per cent of the total number of choppers.

(*d*) *Pointed*. These are usually side choppers. They are characterised by a well-defined median point on the working edge, generally formed by the intersection of a deeply indented flake scar on either side, struck from a flat under-surface. They amount to only 3·7 per cent of the choppers.

(*e*) *Chisel-edged*. The working edge is relatively narrow and lies at right angles to the upper and lower faces of the tools, as in burins. This type of chopper is rare and amounts to only 1·4 per cent.

2. '*Proto-bifaces*'

These tools are intermediate between a biface and a chopper. They are generally bifacially flaked along both lateral edges as well as at the tip. The butts are thick and are often formed by the cortex surface of a cobblestone. Some specimens are high-backed with a flat under-surface and others are biconvex or lenticular in cross-section. The edges are jagged, as in choppers, and are often utilised. These tools are relatively scarce in all industries but are commonest in Levels 3, 4 and 5 at HWK East, where they amount to 2·4 per cent of the total.

3. *Bifaces*

The bifaces from sites in Middle and Upper Bed II (apart from the Lower Acheulean site of EF–HR) are generally crude and there is such a degree of individual variation that it has often been necessary to describe each specimen separately. The few cleavers and picks that occur have been described under the broad term of 'biface' in order to avoid further subdivision in a small series of specimens.

(*a*) *Irregular ovates*. These occur first in the upper part of Middle Bed II. They include elongate and broad specimens as well as those of usual proportions. Some specimens are made on flakes and others on cores. The latter are flaked over both upper and lower faces, whilst in the former the primary flake surface usually shows only a minimum of flaking.

(*b*) *Trihedral bifaces*. These are generally made on flakes, either end- or side-struck. The lateral edges are steeply trimmed and the tips show a minimum of flaking. They are often formed by two convergent scars which intersect on the dorsal face to form a median ridge which frequently does not extend for the whole length of the tools. Trimming on the primary flake surface is usually restricted to the removal of the bulb.

(*c*) *Double-pointed*. This is an uncommon form, but one which is represented at several sites. Both extremities are pointed; the tips are generally shaped by means of convergent bilateral flaking and the butts by two intersecting flake scars or natural cleavage planes.

(*d*) *Flat or square-butted*. This is also an uncommon form. The tools are usually subtriangular and relatively broad at the butt ends, where there is a flat vertical surface. This may be transverse or oblique and consists of either a natural fracture, cortex surface or a negative flake scar.

(*e*) *Cleavers*. Four sites in Middle and Upper Bed II have yielded single specimens of cleavers. No two are alike. They include a well-made example on a side-struck flake with a parallelogram cross-section (EF–HR), a large, damaged specimen (MNK, Main Occupation Site), a U-shaped specimen, trimmed all round the butt (SHK) and a crude specimen made on a broad side-struck flake with a minimum of trimming (BK). In all examples the cleaver edges are relatively wide and formed in the usual manner, by the intersection of one or more flat flake scars, or natural cleavage planes.

(*f*) *Picks, oblong*. These are generally trihedral with a more or less flat under-surface from which the dorsal aspect has been steeply trimmed. The cross-sections are generally triangular, but in specimens where the bilateral flaking does not meet along the centre a flat area is present on the dorsal face, resulting in a roughly quadrilateral cross-section. The tips are sometimes pointed, but more often rounded.

(*g*) *Picks, heavy-duty*. These are massive tools with thick, wide butts tapering rapidly to relatively narrow sharply-pointed tips.

4. *Polyhedrons*

These are angular tools with three or more working edges, usually intersecting. The edges project considerably when fresh, but, when extensively used, sometimes become so reduced that the specimens resemble subspheroids.

5. *Discoids*

These are often irregular, but a bifacially flaked, jagged working edge is present on the whole or the greater part of the circumference. Specimens made from cobbles are usually plano-convex in cross-section with an area of cortex surface retained in the central part of the convex face.

6. *Spheroids*

These include some stone balls, smoothly rounded over the whole exterior. Faceted specimens in which the projecting ridges remain or have been only partly removed are more numerous.

7. *Subspheroids*

These are similar to the spheroids but less symmetrical and more angular.

8. *Modified battered nodules and blocks*

These are various fragments of no particular form but generally angular, which bear a minimum of flaking and some evidence of utilisation.

(There is no clear demarcation between the above three categories, which grade into one another, although typical specimens of each are quite distinctive.)

9. *Scrapers*

The scrapers have been subdivided into two main groups, namely heavy-duty and light-duty. In Bed II sites the former are often made from pieces of tabular quartzite, steeply trimmed on one or more sides and with the upper and lower faces formed by natural flat cleavage planes. Others are made from parts of cobblestones or on large flakes. Most of the light duty specimens are made from flakes and other small fragments of quartz and quartzite. Many of the heavy-duty scrapers are impossible to assign to any particular type and consist merely of amorphous pieces of lava, quartz or quartzite, with at least one flat surface from which steep trimming has been carried out along one edge. The light-duty specimens from Middle and Upper Bed II, however, fall into a number of recognisable groups to which a proportion of the heavy-duty scrapers can also be allocated. These are end, side, discoidal, perimetal, nosed and hollow. A few combination tools with various types of scraper occur at sites in Upper Bed II.

(*a*) *End*. These are almost exclusively within the light-duty group. They are made on flakes or oblong fragments with a working edge at one extremity (only one double-ended specimen is known). The edges are generally curved, but are sometimes nearly straight and often exhibit small projections at the intersection of the trimming scars, or else a slight spur at one side.

(*b*) *Side*. This is one of the most common forms of scrapers in both the heavy- and light-duty groups. The working edges vary considerably, with either shallow or steep trimming. They are usually curved, but some are nearly straight and there is sometimes a slight median projection, as in nosed scrapers.

(*c*) *Discoidal*. These occur in both the heavy- and light-duty groups. The general form is discoidal although the tools are seldom entirely symmetrical and they are usually trimmed on only part of the circumference.

(*d*) *Perimetal*. This term has been employed for scrapers of various shapes (oblong, triangular or formless) in which there is a trimmed working edge on the entire circumference. They occur in both the heavy and light duty groups, but are more common in the latter.

(*e*) *Nosed*. These are mainly confined to light-duty scrapers. There is a median projection on the working edge, either bluntly pointed, rounded or occasionally spatulate, flanked on either side by a trimmed notch or, more rarely, by straight convergent trimmed edges.

(*f*) *Hollow*. Specimens in which the notch is unquestionably prepared are relatively scarce in both the heavy- and light-duty groups, although light-duty flakes and other fragments with notches apparently caused by utilisation are common. In the few specimens which have been deliberately

shaped the notches tend to be wide and shallow rather than deeply indented. They are variable in size.

10. *Burins*

Although not common, burins occur at nearly all Oldowan and Developed Oldowan sites, including the earliest known (DK). Angle burins are the most numerous and are made on transverse broken edges or on trimmed edges, which are usually slightly concave and flaked from the primary surface. Some specimens are double-ended and there are a few with a working edge on either side. Dihedral and polyhedral examples also occur.

11. *Awls*

These first appear in Level 2 at HWK East, at the beginning of the Developed Oldowan. They are characterised by short, rather thick, pointed projections, generally at the distal ends of flakes, but sometimes on a lateral edge. In the majority the points are formed by a trimmed notch, on either one or both sides, but occasionally by straight convergent trimmed edges. The points are often blunted by use and have sometimes been snapped off at the base.

12. *Outils écaillés*

Both single- and double-ended specimens occur. They exhibit the scaled utilisation characteristic of these tools. The edges are blunted and one face is usually slightly concave, whilst the opposite side is straight or slightly convex. They are not known in the Oldowan and occur for the first time at SHK, in the upper part of Middle Bed II (Developed Oldowan B).

13. *Laterally trimmed flakes*

This is a rare tool that, likewise, does not occur in the Oldowan. The flakes are generally elongate and end-struck with one or both lateral edges trimmed for the whole or part of their lengths. The retouch is usually somewhat uneven and the flakes are not entirely symmetrical.

UTILISED MATERIAL

1. *'Anvils'*

These occur at all levels in Beds I and II. In the Oldowan they consist merely of cuboid blocks or broken cobblestones with edges of approximately 90° on which there is battered utilisation, usually including plunging scars. In the Developed Oldowan the anvils have usually been shaped prior to use and are often circular, with flat upper and lower surfaces and vertical flaking on the circumference. Incipient cones of percussion and bruising are sometimes evident on the upper and lower faces, in addition to the utilisation on the edges.

The fact that there is a transition from merely utilised to deliberately shaped specimens has posed a problem in the comparative analyses of the industries, since a distinction has been made between tools and utilised material. It has been considered best, however, to include the anvils as well as the hammerstones among the utilised material, since they represent an aid for tool-making rather than an end-product.

2. *Hammerstones*

The hammerstones consist of water-worn cobblestones (generally lava) with pitting, bruising and slight shattering at the extremities or on other projecting parts.

3. *Cobblestones, nodules and blocks*

These are water-worn cobblestones, weathered nodules and angular fragments that have some evidence of utilisation, either chipping and blunting of the edges or smashing and battering, but no evidence of artificial shaping.

4. *Heavy-duty flakes*

These consist of relatively large flakes with some chipping on the edges. They do not appear in the Oldowan, but occur occasionally in the Developed Oldowan.

5. *Light-duty flakes and other fragments*

Flakes and other small fragments with chipping and blunting on the edges occur in both the Oldowan and Developed Oldowan but are more

common in the latter. They fall into three groups: (*a*) with straight edges; (*b*) with concave or notched edges; (*c*) with convex edges. There is also a miscellaneous group with indeterminate chipping. In specimens with straight edges, chipping is usually evident on both sides, while in the notched and convex series it is usually only present on one face.

DEBITAGE

The term *débitage* has been employed in preference to 'waste' for the unmodified flakes and other fragments, since there are indications at certain sites that some, at least, are not merely discarded by-products of tool manufacture but were made expressly, presumably to serve as sharp cutting tools.

The flakes are almost exclusively irregular and the majority are end-struck. They may be sub-divided into three groups, as follows: (*a*) divergent, splayed outwards from the striking platform (the most common type); (*b*) convergent, with the maximum width at the striking platform; (*c*) approximately parallel-sided (rare).

Re-sharpening flakes are uncommon and are often not represented at all, even in large assemblages. Since cores are virtually absent, they are almost certainly derived from re-sharpening the working edges of choppers.

The highest proportion of *débitage* at all sites consists of broken flakes and chips. There are also small angular fragments apparently derived from shattering blocks of raw material. These have been termed core fragments.

MANUPORTS

These consist mostly of lava cobblestones, weathered nodules and blocks of quartz and quartzite, etc., which lack evidence of modification but which appear to have been imported to the sites by hominid agency.

GEOLOGIC BACKGROUND OF BEDS I AND II STRATIGRAPHIC SUMMARY

By R. L. HAY

Olduvai Gorge is a valley in the Serengeti Plains at the western margin of the Eastern Rift Valley in Northern Tanzania. Where cut by the Gorge, the Serengeti Plain has an elevation of 4,000–4,600 ft. The Gorge is generally 150–250 ft. deep in the lower 13 miles of its course. About 5½ miles upstream the Gorge divides into two branches—a smaller, southern branch, or Side Gorge, and a larger, northern branch, or Main Gorge.[1]

The Gorge cuts into Pleistocene beds more than 350 ft. thick which overlie a trachyte welded tuff, here named the Naabi Ignimbrite, and basement rocks of Precambrian age. Schist, gneiss and quartzite form the Precambrian basement that is exposed in the western part of the Gorge and in several inselbergs near the Gorge. The Pleistocene beds were deposited in a broad, shallow basin that lay on a surface of low relief to the east of Ngorongoro and other volcanoes of the Eastern Rift Valley.

The Pleistocene deposits were first studied by Reck and Leakey in 1931 and 1932, and Reck's short report was published in L. S. B. Leakey's first monograph on Olduvai Gorge (1951). This stratigraphy was largely concerned with the eastern part of the Main Gorge, where lava flows were taken as the igneous basement, and overlying sedimentary rocks, termed the *Olduvai Beds*, were subdivided into five mappable units[2] termed Bed I, Bed II, Bed III, Bed IV and Bed V. Between 1956 and 1961 Dr R. Pickering mapped quarter-degree sheets (scale 1:125,000) that include Olduvai Gorge and its environs to the north (Pickering, 1958) and the adjacent areas to the west (1960*a*) and south (1964).

Beds I–IV*b* are cut by numerous faults but are generally horizontal or nearly so except near a few of the faults. Reck mapped several of the faults, which he numbered as follows from east to west: the First, Second, Third, Fourth and Fifth Faults. Many additional faults are shown by Pickering (1958; in the Press), and a few additional ones were mapped in the course of the present study. Reck's system of numbering is not extended to any other faults. Measured displacements on faults range from about 20 to 120 ft., the maximum figure measured on the Fifth Fault. Several of the faults exposed in the Gorge can be traced for several miles northward across the Serengeti Plain (Pickering, 1958; in the Press), others continue south from the Gorge (Pickering, 1964). Olduvai Gorge drains into Ol'Balbal, a fault graben, the western margin of which may have been dropped down as much as 400 ft. along the First Fault (Pickering, in the Press).

Reck's subdivision into Beds I–IV has generally proved satisfactory and is continued here with some modifications.[3] Bed I is redefined to include all deposits between the Naabi Ignimbrite and Bed II. By this definition the lava flows exposed in the bottom of the Gorge become a member of Bed I and the overlying part of Bed I is termed the Upper Member of Bed I. Bed II as originally defined is continued without modification although a member (the Aeolian Tuff Member) is established within it. Bed III, characterised by reddish-brown claystones and sandstones, interfingers with grey claystones and sandstones similar to those of Bed

[1] Columnar sections of the Main Gorge and Side Gorge (Figs. 1–3) can be found at www.cambridge.org/9780521105187.

[2] In modern stratigraphic practice, Beds I–IV would be considered formations. Each of these Beds or formations comprises many smaller depositional units, or beds.

[3] See note added in proof on p. 18 for subsequent modifications.

IV*a* in the vicinity of JK (Section 14) and FLK (Section 45), and Beds III and IV*a* are not generally separable to the west of the zone of interfingering. Here the equivalent deposits are termed Beds III–IV*a* (undivided).

Deposits now termed Bed IV*a* were previously named Bed IV. A widespread unit generally conformable upon Bed IV*a* is termed Bed IV*b*. It is characterised by aeolian tuffs and in most places is between 5 and 40 ft. thick. The uppermost part of Bed IV*b* contains aeolian tuffs and calcrete over a wide area and is named the Norkilili Member. The Norkilili Member is resistant to erosion and widely forms a cliff along the rim of the Gorge to the west of the Second Fault.

Several of the individual tuff beds in Beds I–IV*a* that were used in correlating are named. These are designated 'Tuff', followed by the formation within which they occur and by a letter designating their position relative to other named tuffs. Tuff I^A for example, is the lowermost marker tuff of Bed I.

Bed V as used by Reck and Leakey comprised deposits of two different stratigraphic units and is abandoned as a stratigraphic term. The older unit, named the Ndutu Beds, comprises conglomerates, sandstones and aeolian tuffs deposited in the Gorge after it had been cut to about three-quarters of its present depth. They are commonly 15–60 ft. thick and contain a Middle Stone Age artefact assemblage. Their sparse mammalian fauna has not been studied. The Ndutu Beds were extensively eroded and the Gorge was cut to its present depth prior to a last widespread series of aeolian tuffs named the Naisiusiu Beds. They generally range from 3 to 20 ft. in thickness and closely resemble some of the aeolian tuffs of the Ndutu Beds. The Naisiusiu Beds contain mammalian bones which gave a C-14 date of 10,400 years (Leakey, Protsch and Berger, 1968). An artefact assemblage termed Upper Kenya Capsian by Leakey (1951) has been collected from the Naisiusiu Beds near the Second Fault.

The faults now exposed in the Gorge were active at various times during the Pleistocene, as indicated by abrupt changes in thickness of stratigraphic units across the faults. A few were active during the deposition of Beds II, III and IV*a*. Others became active during the deposition of Bed IV*b*, and faulting continued while the Ndutu Beds were being deposited. The Balbal Depression, a fault graben, owes its present configuration to the latest episode of faulting, which displaces the Ndutu Beds. This latest faulting lowered the base level, resulting in erosion of the Gorge to its present depth. The Naisiusiu Beds were nowhere found to be faulted and may post-date the latest faulting in this area.

STRATIGRAPHY OF BED I

Bed I was defined by Reck (1951) as a sequence of tuffs between basalt flows in the bottom of the Gorge and 'lacustrine marls' of Bed II. Bed I by this definition forms only the upper part of a conformable sequence of Beds to the west of the Fifth Fault, where the lava flows of Bed I are absent and the base of Bed I as defined by Reck cannot be recognised. In order to make Bed I a mappable unit where the lava flows are absent, it was redefined (Hay, 1963*a*) to include the entire sequence of tuffs and clays between the Naabi Ignimbrite and Bed II. Where fully exposed in the western part of the Gorge, Bed I is generally 100–140 ft. thick. The type section is taken 4·2 miles west of the Fifth Fault on the south side of the Main Gorge.

Bed I of Reck in the eastern part of the Gorge was redefined as the Upper Member of Bed I, the underlying lava flows comprising the Basalt Member (Hay, 1963*a*). Beds below the Basalt Member at the waterfall upstream from the Third Fault form the Lower Member.

Tuffs provide the principal basis for correlating within Bed I. Six of the tuffs are named as follows, from oldest to youngest: Tuff I^A, Tuff I^B, Tuff I^C, Tuff I^D, Tuff I^E and Tuff I^F. Tuffs I^A, I^C, I^D and I^F are ash-fall tuffs that are reworked to varying degrees. Tuff I^B comprises an agglomeratic tuff (i.e. tuff with pumice bombs), of ash-flow origin (= ignimbrite), and an associated ash-fall tuff, both of which are locally re-worked. Tuff I^E is a massive, unstratified agglomeratic tuff that was emplaced as an ash flow. Tuff I^A crops out only in the western part of the Main Gorge; Tuffs I^C and