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Tracks and Tools

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Tracks and tools

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[Plate 1]

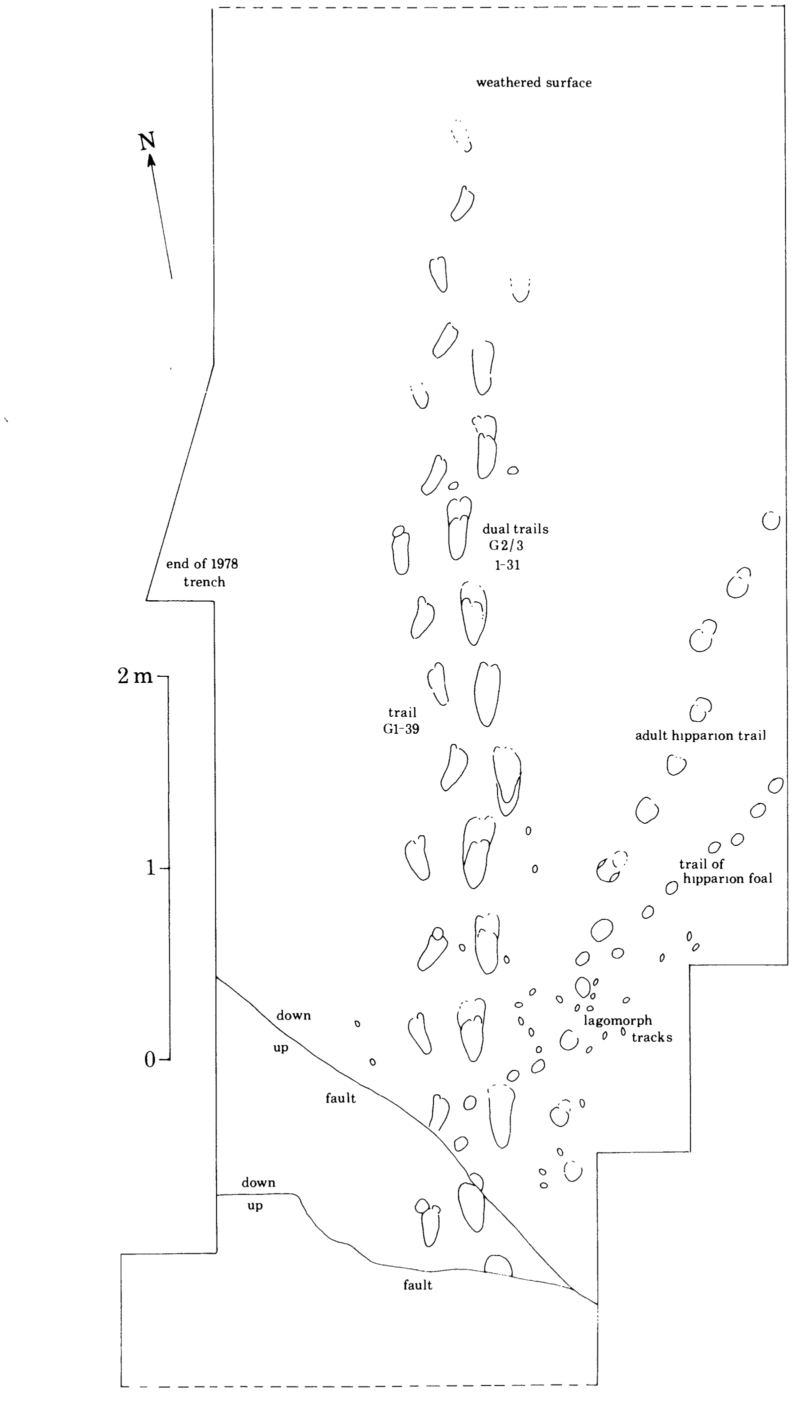
Recent discoveries in the Laetolil beds at Laetoli in northern Tanzania have revealed hominid tracks made by three individuals in a bed of cemented volcanic ash. The tracks extend for a distance of 27 m and indicate a fully upright, bipedal gait with weight distribution similar to that of modern man. A single trail proceeds alongside a dual trail in which the footsteps of the leading individual are almost exactly overprinted by the second set of tracks. Radiometric dating of an overlying tuff has yielded a figure of 3.6 Ma. Stone artefacts are unknown in the Laetolil beds, and a date of *ca.* 2 Ma for the earliest formalized tool-making is postulated on the evidence from Olduvai Gorge.

The evidence from the hominid tracks found at Laetoli will be discussed briefly in relation to the earliest well documented stone tools. This entails bridging a gap of 1.6 Ma, from 3.6 Ma B.P., the estimated date of the Laetoli tracks, to approximately 2 Ma B.P., the date of the earliest tools at Olduvai Gorge. Artefacts from the Hadar in Ethiopia (Roche & Tiercelin 1977) are claimed to belong within this intervening period, but the evidence so far put forward requires substantiation before it can be accepted unreservedly. There are also a few specimens from the Omo valley in southern Ethiopia, which appear to exceed 2 Ma age (Chavaillon 1970). But these hardly represent a stone industry in the accepted sense of the term; some are scattered finds and others are of very low technical standard (see Oakley, this symposium). This somewhat uncertain evidence will be omitted and the discussion will be restricted to the evidence from Olduvai Gorge.

Consider first the Laetoli tracks (figures 1 and 2). The site lies some 30 miles† south of Olduvai (see figure 3) and has been known for its fossils since 1935, when my husband and I visited it for the first time. Since then it has been revisited occasionally, but it was not until 1975 that the first radiometric date of 2.4 Ma B.P. was obtained and it was appreciated that the Laetoli beds considerably antedated the deposits at Olduvai Gorge (figure 4). This date was from a sample of the vogesite lava flows that overlie both the Laetolil beds and the more recent Ndolanya beds. Later the same year, G. Curtis of the University of California, Berkeley, obtained further potassium–argon dates on biotite from the Laetolil beds themselves, which gave average readings of 3.59 to 3.75 Ma B.P.

At that time two hominid mandibles, part of a maxilla, a number of teeth and various mammalian fossils had been found, but it was not until 1976 that A. Hill, palaeontologist at the National Museum, Nairobi, noticed the first fossilized tracks on the surface of a fine-grained tuff. As is so often the case, this was an accidental discovery. The first tracks to be noted were of rhinoceros, elephant, giraffe, various bovidae, carnivores and a chalicothere. Numerous small tracks, abundant at all the known sites, have proved to be of lagomorphs. To date, 15 exposures of the footprint tuff are known, mostly situated on either side of the Garusi Valley

† 1 mile ≈ 1.6 km.



Figures 1 and 2. Laetoli site G. Southern part of the hominid trails. Photograph by J. Reader, National Geographic Society.

and extending over an area of approximately 80 km². The preservation of the footprints has been reconstructed by Hay (Leakey & Hay 1979) and is due to an unusual set of circumstances, which probably occurred over a short period of time, perhaps no more than a month or so.

The footprint tuff is designated tuff 7 in the Laetolil beds and was erupted from the volcano

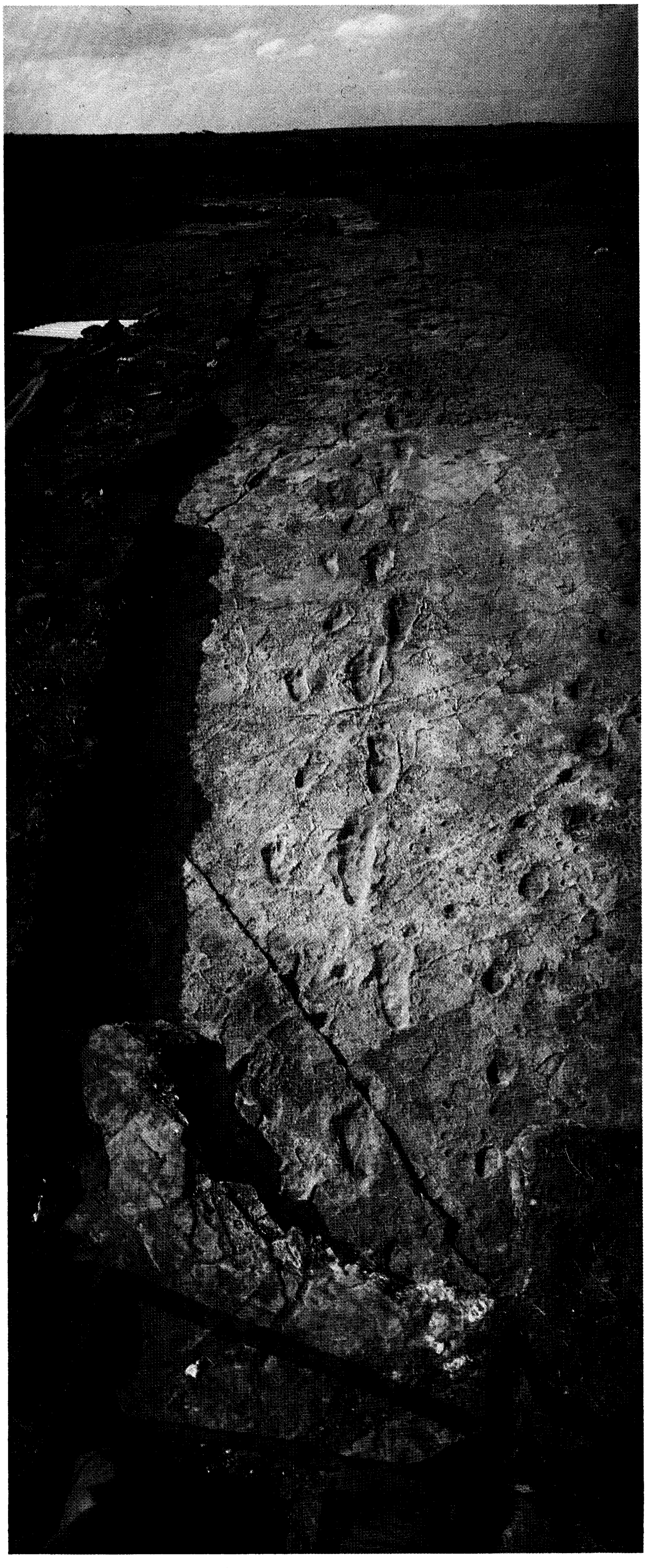


FIGURE 2. For description see opposite.

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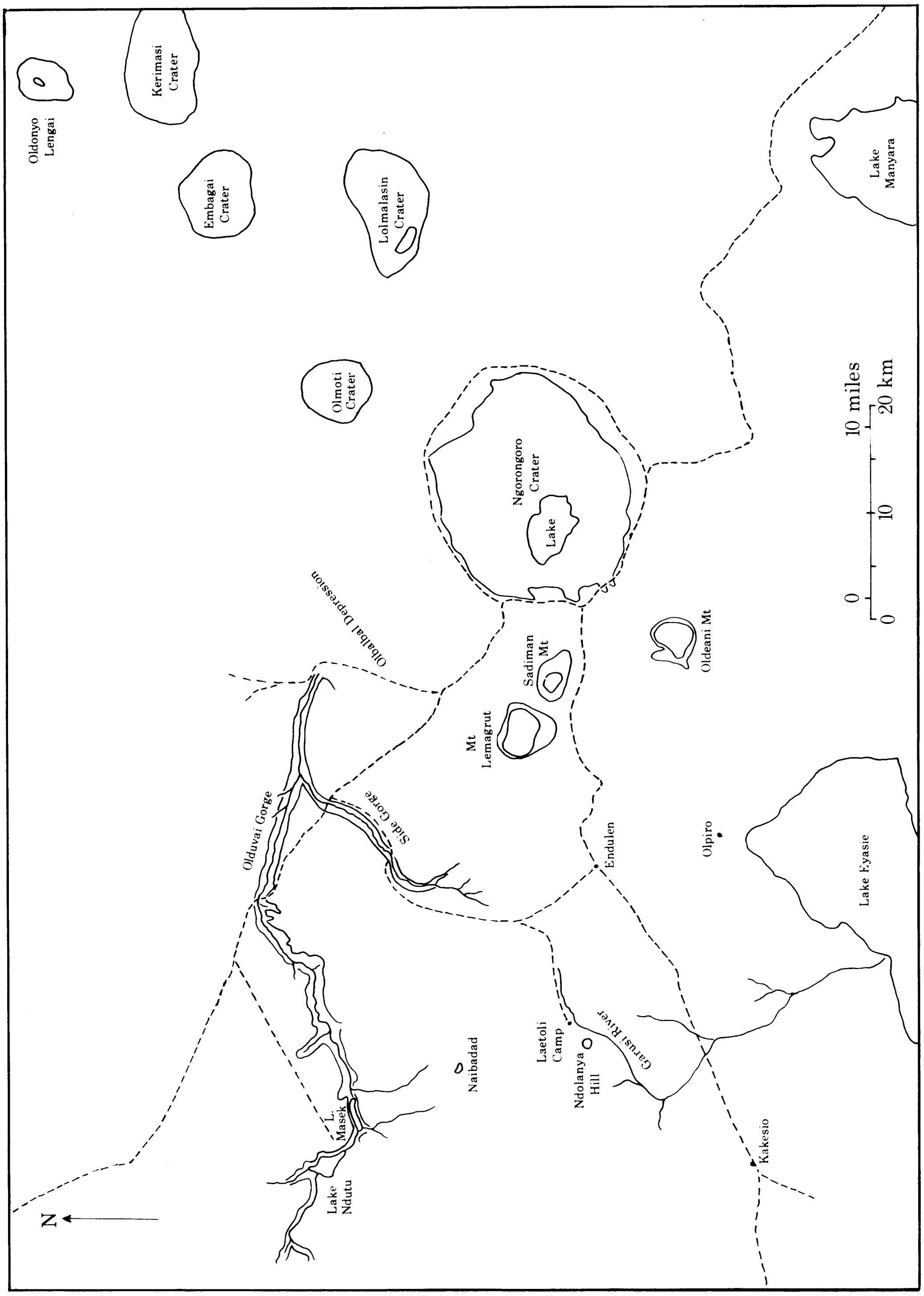

FIGURE 3. From a map compiled by the Serengeti Research Institute.

Sadiman, about 24 km to the east. It is generally 30–50 cm thick and is composed of two units. The upper part is coarse-grained, crudely bedded and contains no footprints. These are confined to the lower unit, a thinly laminated, fine-grained ash, generally $7\frac{1}{2}$ to 8 cm thick. Calcium carbonate or calcite is a major component of the footprint tuff, particularly in the lower unit, where some layers contain more calcite than lava globules. The calcite appears to fill voids from which soluble material like natrocarbonatite ash has been dissolved.

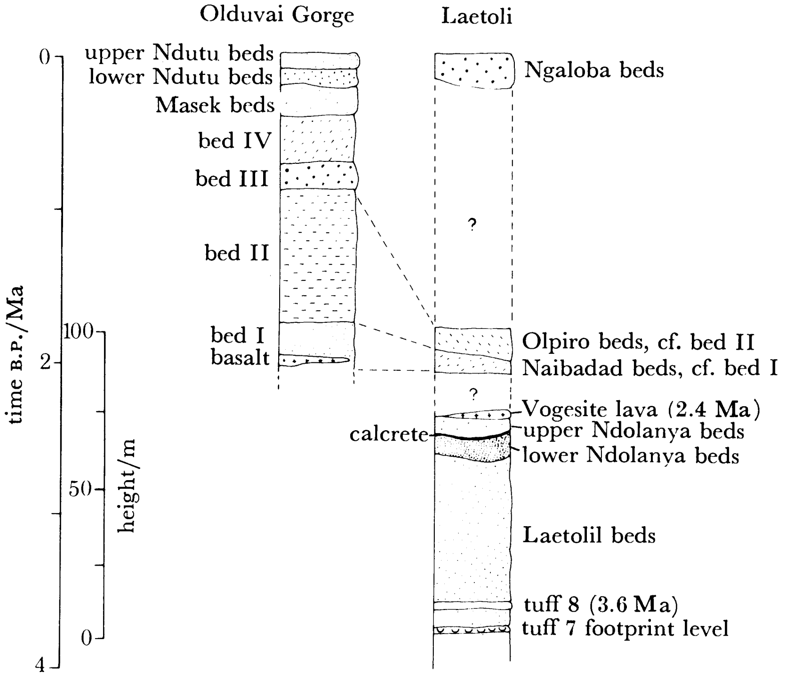

FIGURE 4. Diagrammatic sections to show the time scale and the relationships of the deposits at Olduvai Gorge and Laetoli.

The ash must have been cohesive when it first fell, to avoid erosion by wind under the semi-arid conditions in which a large proportion of the sediments are wind-worked. A close parallel can be seen today at the nearby living volcano of Oldonyo Lengai, where recent falls of natrocarbonatite ash have become quickly cemented by trona.

A number of surfaces with rain drop prints are known in the lower unit of the footprint tuff, particularly towards the base. These clearly represent light showers of rain falling on dry, dusty surfaces, while the upper levels were wetter and muddy. From this and other evidence, it seems that the history of the tuff begins near the end of a dry season and continues into the rainy season. Prints of the larger animals, such as elephant and rhinoceros, together with the hominid prints, occur in the upper, wet part of the tuff. It is noticeable that there are few superimposed prints, a factor that, taken in conjunction with the lack of erosion of the surfaces, confirms the belief that successive ash falls were buried rapidly.

The first footprints believed to be hominid were discovered in 1976. These consisted of a trail of four prints, very broad and presenting some unusual features. They are still partially infilled with matrix, so that the precise shape of the prints cannot be determined. In 1977 a far more impressive trail of hominid prints was discovered by P. Abell of the Department of

Chemistry, Rhode Island University, at a site known as G, approximately 1.6 km distant. He first noted a heel impression in which the front part of the footprint had been broken away by erosion. When overlying ash and recent soil were cleared away, a second print made by the same individual was uncovered, as well as the beginning of another trail, lying to the east. Both trails led almost due north and have now been uncovered for a distance of 27 m from the first heel print. The most southerly part, uncovered in 1979, was still partly overlain by 5–10 cm of the upper part of tuff 7, so that the footprints are completely unweathered and in a most remarkable state of preservation.

It is now evident that the trails were made by three individuals walking together. There is a single trail on the west, made by the smallest individual; the prints to the east were originally interpreted as a single trail made by a much larger individual, but are clearly double, made by two individuals walking in tandem, with the second placing his or her feet in the footsteps of the leader. All three individuals were walking in step and most likely holding one another, since any deviation in course, no matter how slight, is closely followed by all three and the stride length is virtually the same, in spite of difference in the size of the prints. At one point, towards the northern end of the trails, the smaller individual (designated G 1) appears to have paused, made a half turn to the left and then continued onwards. The dual prints to the east are weathered and rather confused in this area, so that it is difficult to determine whether these individuals also hesitated at this point.

In all, 39 prints of the small individual are preserved and 31 of the dual prints (G 2 and G 3). In these it is only possible to measure the length for the leading individual in two prints where the superimposed G 3 prints have not obliterated the heel impressions of the first.

The following measurements have been taken on the 14 prints of G 1 and 11 prints of G 2 and G 3 uncovered during 1979; they must, therefore, be regarded as provisional, pending measurements of the entire trails. The average lengths for the G 1 and G 3 prints are 18.5 and 21 cm, measured from the tip of the big toe to the centre of the heel, the two points that are generally the best defined. The lengths of the two measurable prints of G 2 are 21 and 24 cm. Prints of G 1 and G 3 are, relative to their length, narrower than those of G 2, in which four breadth measurements are possible. Measurements have been taken across the ball, and the length/breadth indices are: G 1 38 %, G 2 48 % and G 3 40 %.

Certain differences between the individual prints in each trail can be observed. In both G 1 and G 3 the average width across the toes is 83 mm, but in G 2 it is 117 mm, with deeper, broader and longer impressions of the big toe. It is evident that the toes in this individual were more splayed than in either G 1 or G 3. Gait also varies. The individual G 1 walked with feet splayed outwards with an average angle of 27° from the centre line of the trail. The angles of the prints in trail G 3 are patently not measurable, since this individual was following in the footsteps of G 2. Although the G 2 prints generally lack heel impressions it is evident that they were markedly less everted than those of G 1. Some are parallel to the midline of the trail and the average angle of eversion is 3°. In all three sets of prints the weight has been borne on the heel and lateral edge of the foot, but in G 3 the ball is relatively more deeply depressed than in G 1, in which the heel impressions are remarkably deep.

The trails are virtually in a straight line for the entire distance of 27 m. Subsequent faulting with lateral as well as vertical displacements has cut through them diagonally in several places.

Various experiments were carried out at Laetoli in an endeavour to simulate the conditions on the three trails. It was found impossible for adults of present-day stature to walk abreast as

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closely as did the individuals G 1 and G 2/3, in which the average distance apart for the recently discovered trails is only 17 cm. It is possible, however, for children to walk closer together.

Calculations based on the length of the foot can give an approximate estimate of stature, although even among the living races of *Homo sapiens* the recorded ratios of foot length to known stature vary from 13.4 to 16 % (Pales 1976). In the Pliocene hominids the percentages may have been much greater or much less. However, with the figure of 15 %, considered to be most generally acceptable, approximate estimates of stature for the two individuals in which the length of the footprints can be measured are: G 1 123 cm (4 ft 1 in) and G 3 140 cm (4 ft 7 in).

The third individual, with the broader foot, was probably rather taller than either of the other two. Even so, it seems reasonable to conclude that the stature of the three individuals was between 4 and 5 ft (*ca.* 1.2 and 1.5 m).

Interpretation of the behaviour pattern shown by the Laetoli hominid tracks can only be hypothetical and depends to a large extent on whether one considers a human or an ape-like model to be the most acceptable. If one is prepared to believe that these hominids were already on the road to man, and were not primates with a tendency to ape-like behaviour, then it is plausible to interpret the tracks as being made by a male whose foot had broad, splayed toes, closely followed by a female, with one or the other leading a juvenile. On the other hand, it seems that juvenile gorillas and chimpanzees often proceed in tandem, while at play, holding one another round the hips (Schaller 1963; A. Root, personal communication).

We have been unable to discover any evidence whatsoever for the making or using of stone tools in the Laetolil beds. A diligent search has been carried out annually and it can now be stated with some confidence that the deposits in the Laetoli area carry no imported stones; in fact, the only stones to be found are fragments of ijolite, volcanic ejecta from the volcano Sadiman.

I turn next to the evidence of the stone industries from Olduvai Gorge. The earliest industry, known as the Oldowan, is situated stratigraphically immediately above the basalt flows in bed I and is dated at 1.9 Ma B.P. This industry has been found at a number of camp sites along the shores of the former Olduvai lake. Tools, debitage and food debris occur in close association and in apparently undisturbed conditions.

The earliest tool kit contains six recognizably different tool types: choppers, polyhedrons, diskoids, subspheroids, scrapers and burins. The choppers, moreover, can be subdivided into a number of different types, such as side, pointed, two-edged and chisel-ended. Side choppers are by far the most common, both at this level and in later stages of the industry. They consist of oblong, fist-sized water-worn cobbles, crudely flaked along one of the longer sides to form a sharp, but jagged, working edge. As well as the formalized tool types, the Oldowan industry also contains numbers of sharp, unretouched flakes with chipping and evidence of wear along the edges. Although these might be regarded as waste material, knocked off when making or resharpening heavy-duty tools, the flakes are usually of quartzite, whereas the majority of heavy-duty tools is of various lavas. It seems, therefore, that they are a separate class of artefact that served a specific purpose.

The deposits of bed I above the basalt flows are believed to have lasted no more than 0.15–0.2 Ma. During this time there is little evidence of change or expansion in the Oldowan industry, although the tools from the lowest level, at site DK, tend to be rather smaller than those from the higher levels. At site FLK North, at the top of bed I, the manufacture of choppers appears to have reached its zenith. At this level, too, there is a single example of a pitted anvil, indicating, perhaps, the beginning of a bipolar technique of flaking stone, which became widely used in the upper part of the Olduvai sequence.

Even though the first hominid remains from bed I were discovered in 1959, there is still no universal agreement as to whether two or three taxa were present at Olduvai during bed I times. *Australopithecus boisei* is accepted as a robust australopithecine, but is not generally considered to have been the maker of the Oldowan tools; it seems more likely to have used natural objects for various purposes, probably adapting them to its needs with teeth and hands, but incapable of formalized tool-making to regular patterns.

The first remains of *Homo habilis*, found in the early 1960s, soon after the discovery of *Australopithecus boisei*, aroused considerable controversy, and the creation of a new species of *Homo* by Leakey *et al.* (1964) raised a storm of protest. Over the years, this has gradually subsided and the discovery of the cranium of '1470' by R. Leakey in 1972 seems to have brought about a general recognition that there was a stage in human evolution antecedent to *Homo erectus*, but in the direct lineage of *Homo*, to which the term *Homo habilis* could be applied.

However, some workers have now raised the question as to whether all the hominid remains from bed I and lower bed II, other than those of *Australopithecus boisei*, belong to the taxon represented by the type mandible and parietals of O.H.7 (Walker & Leakey 1978). It has been suggested that, whereas the cranial capacities of O.H.7 and '1470' are compatible, other crania from Olduvai, notably O.H.13 and O.H.24, fall below the acceptable level and may belong to another species, perhaps *Australopithecus*. But, since the extent of sexual dimorphism in *Homo habilis* is not known, it is possible that the smaller-brained crania may represent the females of *Homo habilis*. Whichever solution may eventually prove to be correct does not affect the fact that a crude but formalized stone industry existed at Olduvai approximately 2 Ma ago.

Besides the mandible and cranial parts of the *Homo habilis* type, some hand and foot bones were also discovered at the same site. From these it was deduced that the gait was fully bipedal and free-striding (Day & Napier 1964) and that the hand bones were adapted for a precision grip (Napier 1962; Susman & Creel 1979), a conclusion amply supported by the small Oldowan tools. Thus, at Olduvai, it can be shown that both free-striding bipedalism and manual dexterity existed just under 2 Ma ago. At Laetoli, there is evidence only for bipedalism, which freed the hands for purposes other than locomotion. To what extent the hands were used is unknown, but it can be accepted that manufacture of stone tools was still in the future.

In the hominid fossils recovered from the Hadar in Ethiopia (Johanson & White 1979), which are clearly related to, but perhaps later than, those from Laetoli, the cranial capacity is said to be small and has been described as 'ape-like'. Hand bones are also known and when detailed anatomical studies of this important material have been carried out they may provide a clue as to whether the brain or the hands developed first, or whether they both progressed simultaneously.

In conclusion, it can be stated that the evidence from Laetoli demonstrates that as early as 3.6–3.8 Ma ago man's ancestors had achieved a fully upright, free-standing, bipedal gait, which automatically freed the hands for purposes other than locomotion. It is not, however, until from some 1.6 Ma later, at Olduvai, that the first firmly dated and incontrovertible evidence for manufacture of formal tools is to be found. Artefacts from the Hadar, claimed to be in the region of 2.6 Ma old, may prove to fill this gap, but cannot be accepted unreservedly until the present evidence is substantiated.

During the interval between 3.8 and 2 Ma B.P. the early hominids must have progressed slowly through the stages of selecting naturally shaped objects to assist them in their activities, adapting objects by means of their hands or teeth, haphazardly breaking stones and, finally shaping stone tools to a recognizable pattern, an achievement rendered possible by the development of the precision grip and intellectual ability for conceptual thought.

Reference to the term *Australopithecus afarensis* as applied by Johanson & White (1979) to both the Laetoli and Hadar hominid material has been omitted until now, since it is largely a matter of semantics and does not affect the evidence. However, the arbitrary application of the same specific name to the hominids from the two localities, which are separated by over 1000 miles, appears to be based on insufficient proof of identity. It would have been desirable for a detailed comparison to be made of such material as is common to both sites. It is regrettable, too, that the type specimen selected for *A. afarensis* should be a worn mandible from Laetoli, when much better-preserved specimens are available from the Afar itself. Moreover, on the available evidence, it is questionable whether all the Hadar material belongs to a single species; if so, extreme sexual dimorphism must have been present. The possibility exists that two taxa are represented, as originally postulated by Johanson.

Whether the term *Australopithecus* can correctly be applied to fossils that appear to be in the direct *Homo* lineage is a matter of opinion, but the evidence at present available is capable of two interpretations: that *Australopithecus* branched off from the stock leading to *Homo* before the Laetoli and Hadar hominids and later coexisted with them, or that man's ancestors passed through an australopithecine stage of evolution. To assume tacitly, by applying the term *Australopithecus*, that the second alternative is necessarily correct, does nothing to clarify one of the most important issues in the study of man's evolution.

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FIGURE 2. For description see opposite.

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