# When Stones Can Be Deceptive

*A young archeologist has been making and using hundreds of stone tools in order to learn what our ancestors did with them; some unexpected results emerged*

STONE artifacts are the most durable products of prehistoric human activity and, inevitably, they have been the subject of fascination for archeologists for a very long time. The complexity of "tool kits" has, for instance, been taken not only as an indication of how our forebears might have subsisted but also of how smart they were: the repeated manufacture of a suite of distinct artifact designs is interpreted as the product of significant cognitive capabilities. The identification of the different types of artifacts within an assemblage has therefore been a major preoccupation of archeology.

It seems likely, however, that in the earliest artifact assemblages, which go back to around 2 million years in East Africa, archeologists may have been misled by a morphological complexity in tool types that is more apparent than real.

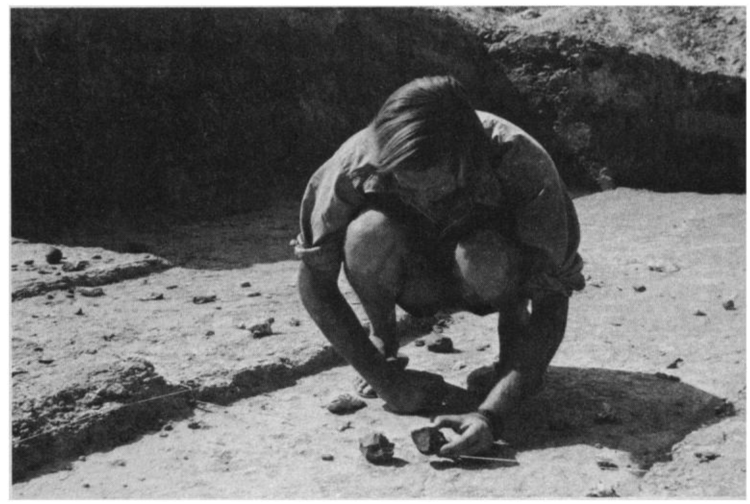
Nicholas Toth of the University of California, Berkeley, and the Institute of Human Origins, Berkeley, has concluded that the half dozen or so putative tool types that are typically found in these earliest assemblages are in fact often not tools at all in the generally accepted sense. They are not necessarily the product of intentional design, in which the manufacturer follows a standardized mental template, he says, but instead are the by-product of casual flaking. These so-called core tools very probably were put to use in various chopping or scraping functions, but the sharp flakes knocked off the cores were the principal concern of these early stone knappers, argues Toth.

These conclusions are the outcome of a detailed analysis of archeological material combined with insights gained from experimental stone knapping and the use of these artifacts in butchery, hide working, and woodworking, for instance.

Following the inspiration of the late Glynn Isaac of Harvard University, Toth pursued a long program of stone toolmaking, with several questions in mind. For instance, by working with the same raw material found at the early sites in East Africa Toth hoped to explore the technological constraints that might have influenced the physical characteristics of archeological assemblages. And by comparing the material—including flakes and cores—he produced during casual stone knapping with that found on archeological sites, he expected to be able to address some behavioral issues too, including the general modes of subsistence. Surprisingly, he was also able to ask whether these ancient hominids were right- or left-handed (see box on page 115).

**Artifacts compared**

*Toth compares a polyhedron he made with one at site 50, on the eastern shore of Lake Turkana in northern Kenya. The artifacts at the site were made approximately 1.5 million years ago.*



If one looks back through the archeological record a couple of basic patterns emerge. The first is that the number of tool "types" identifiable at any one time decreases the further one goes back, from 100 or more in the Upper Paleolithic (10,000 to 50,000 years ago) to a mere half dozen or so in the oldest assemblages around 2 million years ago, which are generally known as Oldowan. The second is that in the more recent assemblages the artifacts are often carefully fashioned, relatively small flakes, which pattern holds in the Upper Paleolithic and through the Mousterian, some 150,000 years ago. Prior to that the Acheulian assemblages, which extend back to about 1.5 million years ago, and the Oldowan beyond, the artifacts are considered to have been "core tools," which were fashioned by the removal of flakes from a cobble, often of basaltic lava.

The classification of the earliest core tools—as choppers, discoids, spheroids, protobifaces, and so on—was developed by Mary Leakey who, during her pioneering work at Olduvai Gorge in Tanzania, applied the typological approach that had been established for the European Upper Paleolithic. Although she recognized that the flakes that had been knocked off the cores were probably used by the hominids of the time, they were classified generally as debitage, or waste. The emphasis was always on the core tools, as is reflected in the many pictorial reconstructions of proto-humans wielding jagged choppers over bloody carcasses.

Toth's work shifts the emphasis from the cores to the flakes. "The results of my study suggest a need to rethink some common assumptions about the nature of these early stone technologies," he notes. "Based on my experimental work, it seems likely that much of the variation in Oldowan technology often attributed to stylistic norms is in fact the end product of a lithic reduction designed to produce sharp flakes, and that many of these core forms may actually be 'waste'."

Effective stone knapping is not as easy as might be imagined: the selection of a suitable angle to strike on the core, typically about 70 degrees, is crucial, combined with a powerful but controlled glancing blow with a hammerstone. Once Toth had mastered the basic skill, he embarked on a program of analysis of the products of casual flaking, using lava cobbles, and to a lesser extent ignimbrite, quartz, and chert, similar to those on the archeological sites east of Lake Turkana in northern Kenya.

One interesting observation was that the hominids of 2 million years ago clearly had a good eye and a skillful touch in striking flakes. By comparison with the flakes Toth produced using an intentionally casual, minmum-skill technique, those from the archeological sites were generally longer and thicker. "They were choosing the regions of high mass on the cores," says Toth, "the long ridges that produce the best flakes when struck correctly."

The key observation of this experimental archeology, however, was that Toth generated the series of "core tools" that characterize Oldowan assemblages, but without any premeditation. The shape of cobble selected as starting material appeared to have a major influence on the final product. For instance, a wedge-shaped cobble can be transformed into a unifacial chopper with the removal of just a couple of flakes; further flaking gives a bifacial chopper; and still further flaking produces a polyhedron.

A hemispherical cobble is more varied in its potential transformations and can yield a core scraper in addition to unifacial and bifacial choppers and discoids. As might be guessed from this end product variability, there is in fact a good deal of overlap between the half dozen or so morphological types in the Oldowan assemblage. If one thinks of each type as a rise on a morphological landscape, one would see rounded hillocks rather than sharp peaks, each barely separated from its neighbors by shallow valleys. Only much later in the archeological record do sharp peaks and deep valleys begin to develop.

This morphological continuity in the Oldowan assemblage arises in part because flaking is a very ad hoc affair, and although initial form is highly influential on the final product, the cobble may fracture in unexpected ways, which takes the subsequent flaking activity in a new direction. Now, archeologists have noticed that the scope of the morphological landscape may vary between different archeological sites: some contain the full range of identified types whereas others are restricted to just a few, an observation that has invited functional and behavioral interpretations. But, warns Toth, there may be other explanations.

In a survey of the various archeological sites on the east side of Lake Turkana, Toth noted that those nearer the lake edge had relatively small lava cobbles available as raw material, whereas those nearer the margin of the basin, which is closer to the source of the volcanics, had the choice of larger cobbles. This is significant because experimental stone knapping shows that the number of core tool types produced during flaking increases with an increase in the size of the starting material. Therefore, concludes Toth, "much of the observed range of variation in core forms could be, to a large extent, due to variation in the size of the available raw material."

These several lines of evidence—from experimental flaking and physical constraints imposed by size and shape of raw material—can be taken to imply, but not prove, that the core tool types are indeed by-products rather than the principal goal of stone knapping. A clearer answer could be reached if it were possible to determine what the various artifacts had indeed been used for.

**To make a chopper**

*The sequence of flakes, from left to right, were detached in the manufacture of the simple chopper (in hand).*

Some years ago Lawrence Keeley of the University of Illinois developed a technique for distinguishing between different types of "polish" imparted on stone tools when they were used in, for instance, cutting meat, whittling wood, scraping skins, and cutting grass. The technique works very well with tools made from crystalline silica but, unfortunately, the surface of basalt lava weathers very readily through time and most telltale signs of use are obliterated. And as 95 percent of the artifacts on the East Turkana archeological sites are made from lava, there is something of a problem.

Nevertheless, Toth managed to collect together 54 nonlava artifacts, cores, and flakes from two sites and subject them to polish analysis with Keeley. Only nine showed clear signs of use: four in slicing meat, two in cutting soft plant material, and three in woodworking. But all nine were flakes or flake fragments, not cores. "It is interesting that none of these used pieces would have been placed in the 'tool' category typologically," notes Toth. An additional "classic" chopper was examined subsequently, and this showed no signs of use.

The degree to which hominids of between 1.5 and 2 million years ago included meat in their diets and the manner in which it was obtained is currently a matter of some debate among archeologists. But the fact that some animal bones from some archeological sites of the period display what have been interpreted as indications of hominid activity indicates that at least some butchery was carried out. And as the great majority of these marks appear to have been inflicted by sharp flakes used in a slicing motion, whereas trauma from chopping tools is only rarely found, it seems reasonable to infer that flakes were indeed important in certain aspects of butchery.

In Acheulian assemblages, which first appear about 1.5 million years ago, the range of core types expands to include so-called hand axes and cleavers, both of which Toth finds from experimental test to be excellent large-scale butchery implements. Acheulian hand axes are sometimes crudely fashioned and at others exquisitely formed, having the symmetrical shape of a teardrop. Here, for the first time says Toth, one has the sense that the stone knapper had a clear mental template that was being imposed on the raw material. Here the imposition of arbitrary form, a clear signal of cognitive advancement, appears to be manifest. And its first appearance in the archeological record coincides with the first earliest record of the bones of *Homo erectus*, the presumed descendant of the earlier *Homo habilis*.

How much of a measure of intelligence the cruder forms of the Oldowan can be taken to be is problematical, because when the early Acheulian hominids worked with cobbles they produced a range of forms indistinguishable from those of the Oldowan. And some archeological sites of just 10,000 years ago or so in Southeast Asia, Australia, and Tasmania, which clearly were the products of modern humans, displayed no greater imposition of arbitrary form than is seen in the oldest sites. There surely was an increase in cognitive skills from 2 million years ago, with *Homo habilis* and the Oldowan, through *Homo erectus* and the Acheulian, and on to *Homo sapiens* with the Mousterian and Upper Paleolithic, but, warns Toth, the crudeness of any particular assemblage is not necessarily a good guide to brain power. It can be taken only as an indication to the minimum level of intelligence being displayed, not the maximum.

The more advanced hominids, with their expanded intelligence, almost certainly were more organized in their subsistence activities, including selecting and storing raw material for artifacts, while the earliest hominids are generally thought of as being more opportunistic. Again, as a generalization this must be true, but there is evidence that even

2 million years ago a fair amount of premeditation went into stone toolmaking and use.

As part of his experimental stone knapping Toth established a scheme that characterized the various stages of flaking. "A given core type produces a predictable set of flake types," he explains, "and hence the manufacture of a given set of cores generates a predictable population of flakes within an assemblage." On examining the artifact material on a number of sites at East Turkana, it became evident that very often the later stages of flaking were preferentially represented. The first flakes to be struck from a core, which can be identified by their high cortex content, were frequently missing. And on one site, known as site 50, only six cores of a total of 63 had flakes that could be fitted back, jigsaw style.

Toth joined forces with Kathy Schick, also of Berkeley, to determine whether the population of flakes at any particular site was being distorted by, for instance, water action during burial. Using direct experimentation and computer simulation they were able to demonstrate that any such effect would distort in favor, not against, the cortical flakes.

With all these lines of evidence at hand, Toth envisages that the hominids of 1.5 to 2 million years ago operated with considerable planning. For instance in many cases they clearly carried suitable raw material several kilometers from its source to where it was finally used. Some initial flaking may have been done to test the qualities of the potential cores at the source site. And selected pieces were then taken to activity areas, whether for butchery or other purposes, where more flakes would be removed. The best pieces would then be taken to new sites of activity, flaked further, finally to be disgarded when the core became too small or the striking angle too steep.

Toth is quick to point out this is simply a behavioral model, built on the results of direct tests of the archeological record, and requiring yet more tests before it can be confidently supported.

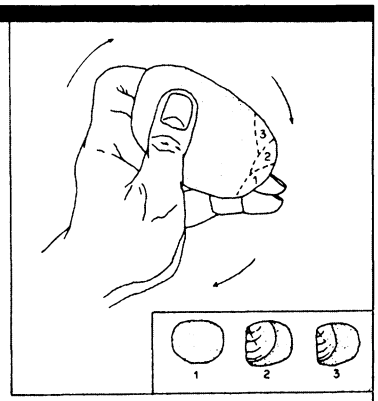
The combination of experimental and traditional archeology described here has allowed some questions about hominid behavior and subsistence to be addressed directly that previously were largely matters of unconstrained speculation. The power of the approach is a tribute to Glynn Isaac's imaginative and insightful gift to modern archeology. ■ ROGER LEWIN


ADDITIONAL READING

N. Toth, "The Oldowan reassessed: a closer look at early stone artifacts," *J. Arch. Sci.* 12, 101 (1985).

L. Binford, *In Pursuit of the Past* (Thames and Hudson, New York, 1983).


# Dexterous Early Hominids




**Handedness revealed in the stones**

*Right-handers hold the stone in the more passive left hand, rotate it clockwise, and strike flakes in the sequence shown. The right-oriented flakes (2 and 3) have a crescent of cortex or weathered surface to the right edge. The majority of early hominids appear to have been right-handed.*

About 90 percent of modern humans are right-handed, which makes us different from the rest of the animal world, including our closest relatives the great apes, in which preferential handedness, where it exists, is usually 50:50, right to left. Anthropologists are therefore interested in two questions: why did preferential handedness arise on a population level and when did it first occur? The anthropological literature has no shortage of answers to the "why" question, but most reside within the realm of speculation, for the very good reason that it is exceedingly difficult to approach directly. The "when" question should be more tractable, as the prehistoric record contains the products of early hominid activity, to wit stone artifacts, upon which the mark of handedness might conceivably have been imposed.

So it was that when Nicholas Toth, of the University of California, Berkeley, and the Institute of Human Origins, Berkeley, combined experimental stone knapping with traditional archeology he found himself, somewhat to his surprise, with an insight at least on when handedness first arose. The clue lies in the configuration of flakes that the early hominids generated as part of their "tool kit." Right-handers produce slightly more flakes that have a crescent of cortex (weathered surface of the cobble being struck) on the right side of the flake than on the left (see diagram above). This occurs because when a right-hander is striking a series of flakes from a core, which is held in the more passive left hand, the hand turns in a clockwise direction, for structural and muscular coordination reasons. Left-handers do the reverse. This insight stemmed directly from Toth's experimental flaking work.

To find out whether hominids that generated any particular archeological site were preferentially handed, and if so, in which direction, all that is necessary is to collect the flakes that bear cortex—only about a quarter do— and look where the crescents lie. Toth has done this with seven sites east of Lake Turkana in northern Kenya, which date between 1.5 and 2 million years old, and a more recent site in Spain, which is perhaps 250,000 years old. In all cases the right-hand bias comes through: in the Kenyan sites by 57 to 43 percent and the Spanish site by 61 to 39 percent. By comparison, in Toth's own (right-handed) stone knapping, in which he made 125 cores and 1569 flakes, the count comes to 56 to 44 percent right-hand bias. The count is not further skewed than this, Toth explains, because flaking is a very ad hoc affair, with the search for appropriate acute angles being the key element: only rarely does a neat, sequential series of flaking present itself.

The fact that the hominids of 2 million years ago (presumably *Homo habilis*) generated the same flaking pattern as modern *Homo sapiens* (Toth) might be taken to imply that preferential right-handedness was already fully developed as a population phenomenon. It would be instructive to examine other archeological sites throughout the record to see how consistent the pattern is. ■ ROGER LEWIN


ADDITIONAL READING

N. Toth, "Archeological evidence for preferential right-handedness in the lower and middle Pleistocene, and its possible implications," *J. Human Evolution* 14, 607 (1985).