

## CALICO --- THE OLDUVAI GORGE CONNECTION

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*I recently stumbled upon a long-buried 1938 paper describing an experiment designed to help archaeologists distinguish lightning spalls from primitive stone tools. Six rocks were collected from the Calico Hills and taken to the high-tension lab at the California Institute of Technology, where two spalls were successfully knocked off one rock. These lab specimens matched suspected natural geofacts the 1938 workers found earlier on the surface of the yet-to-be Calico site. Twenty-five years later, L. Leakey unwittingly placed Calico master pit I in the exact same section studied in the previous 1938 work. The personal study of this previously unknown coincidence in archaeology led the author to question whether Leakey's East African Oldowan specimens could be crocodilian gastroliths rather than the first proto-tools.*

How did I, a dedicated Great Basin avocationalist, get the nerve to question the East African work of one of the most significant archaeologists of the twentieth century? In 1965, Louis Leakey (Leakey et al. 1968), fresh from his triumphant discovery of the 2-million-year-old tool-making hominids in East Africa, came to California and stunned the world when he announced in the journal *Science* that evidence of early man had turned up at the 200,000-year-old Calico Early Man site (CA-SBR-2102) near Barstow.

Over the next three years, Leakey and Ruth Simpson examined millions of rocks at the Calico Hills and found a few seemingly chipped and flaked specimens that, according to Leakey, were probably stone tools fashioned by early humans, but the consensus in the archaeological community was that Leakey was mistaken (Dixon 1988). Haynes (1973:9) argued that the Calico specimens were actually "geofacts" shaped by natural geological forces that had been pushing and grinding the rocks for millennia. Leakey's visit to California in 1963 unleashed one of the major archaeological controversies of North American history. I was new to Great Basin archaeology and I remember the times well. Thomas summed up the frenzied nature of the investigations in this succinct paragraph:

Specialists from both sides of the issue have tried about everything to prove their respective points. Flintknappers have worked over quarry samples from nearby roadways and mines, where vehicles and heavy equipment have caused breakage. Experimenters at the San Bernardino County Museum dropped a fifty pound boulder onto a block of Calico chalcedony, shattered stones with dynamite, tumbled rocks for twelve hours, crushed them with an eight-ton road-roller and passed them through mechanical rock crushers, all in an attempt to simulate geological forces through time. Others have measured the edge angles, looked for damage on the tools from ancient butchering activities and about everything else conceivable that one can do to a rock [Thomas 1994:45].

Many years later, just after Ruth Simpson's death in 2001, long after all the controversy had subsided, I was in the Long Beach public library looking through back issues of the now defunct *Desert Magazine*, a popular magazine which ran from 1937 to 1985. I was very fond of the old artistic maps and came across an especially good one. I immediately recognized the area to be near Barstow. The map had four curious, tiny little Xs just exactly where the Calico site would be placed 20 years later (Figure 1). There were two little words next to the tiny Xs and I expected them to say Calico site, but instead they said "Lightning spalls." My brain made an instant disconnect. I thought to myself, "lightning spalls"? Primitive stone tools? They can be hard to tell apart. I thought, this story can't possibly mean what I think it means, but then I read the story and that's exactly what it did mean (Laudermilk 1943). Fortunately the

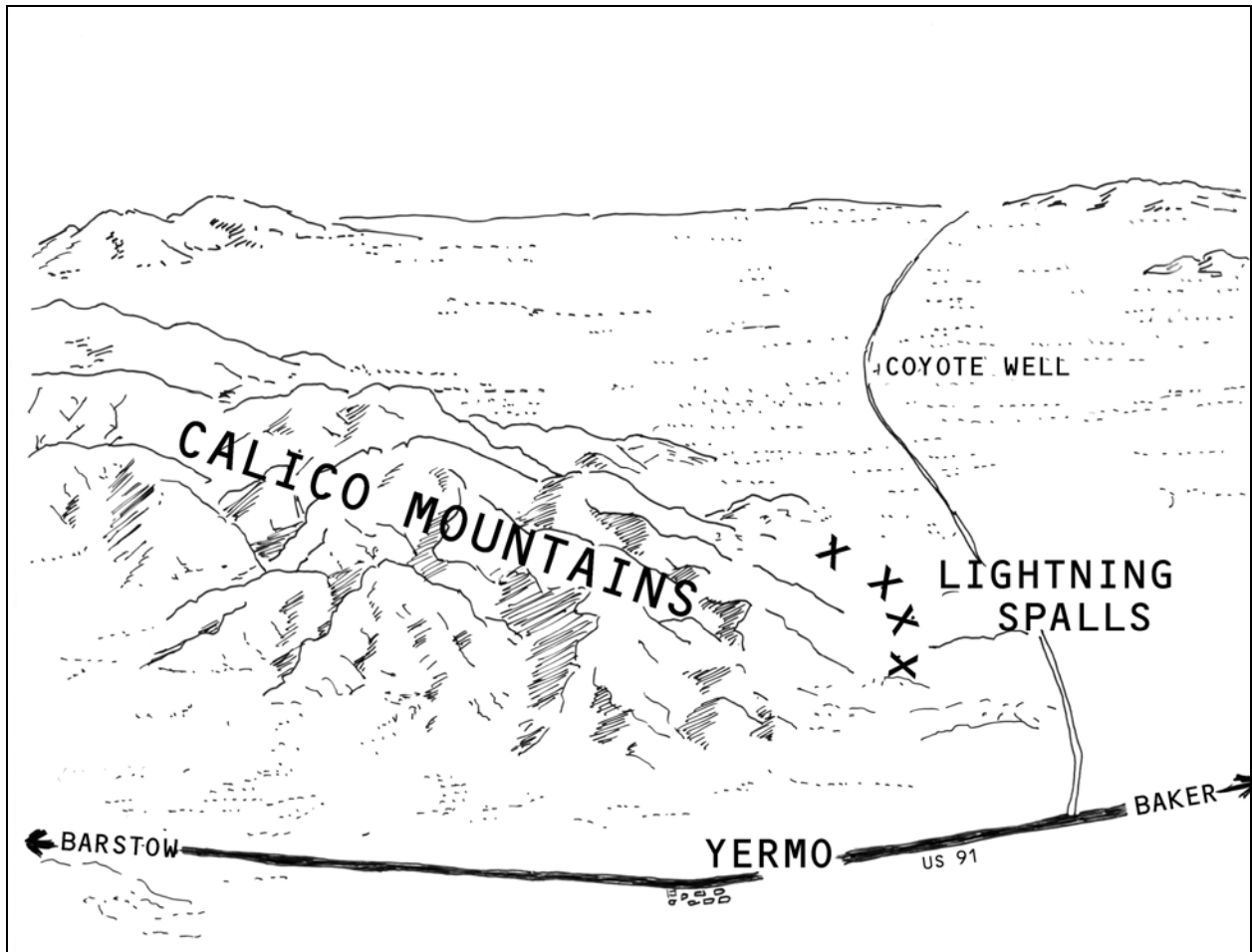


Figure 1. Detail of October 1943 Desert Magazine map showing 1930s lightning spall study area clearly marked exactly where Leakey would place Calico master pit I 20 years later. Figure redrawn after Norton Allen.

story referred me to an earlier 1938 published professional paper revealing the details of an early 1930s lightning spall study on the exact same site Leakey was to visit 25 years later (Laudermilk and Kennard 1938).

I couldn't believe what I was looking at – nobody ever even knew this prescient work so much as existed until I stumbled upon it that day in the Long Beach public library. I wanted to publish it with my name – just for my personal moment of glory. I wanted to impress my peers, who are mostly a lot of other avocationalists. The problem is that I can't easily write at close to the professional level, but felt I must try. I appreciated good science writing but found it difficult to get up to the proper level myself. In all I worked on it for four summers.

While writing, I had to keep going back to the library, comparing Leakey's African specimens to the Calico specimens which are all but identical in form and size. As I did so, I grew a bit skeptical of the East African identifications; but who am I to question the giants of East African archaeology? The lithics are simple. The specimens are just rocks and can be identified as tools by provenience alone. Most are whole rocks, some just fragments or flakes such as one would find readily in any desert pavement. I wondered if the tools might not just be some sort of gastrolith, but the only animal I could think of that

could produce them was the ostrich, which clearly didn't seem large enough to swallow stones the size of the Oldowan specimens.

My inspiration came one Tuesday morning, when, as I always do Tuesday mornings, I picked up a copy of the weekly *New York Times* science page. I noticed a review of a book entitled *You Belong in a Zoo* by Peter Brazaitis (2003), the retired chief of New York's Central Park Zoo. The review said:

Crocodiles, like birds swallow rocks. Scientists working in Uganda had shown that crocodiles always swallowed stones equivalent to 1 percent of its body weight. Curious to see how they managed that as they grew, Brazaitis put three baby crocodiles into a stone filled pond. X rays showed that over night they swallowed about 1 percent each. Then he let them grow for a year in a stoneless pond, and finally put the heaviest in with stones so big that it could not swallow one without going well over one percent. The next morning not only had the right weight in the new stones been eaten, but the crocodile had regurgitated some of the old stones. The crocodile had made change. Let's see a bird do that [McNeil 2003].

As soon as I read the word "regurgitate," I sensed there might be a real problem with lithic interpretations out at Olduvai Gorge, Tanzania.

### **LAUDERMILK AND KENNARD IN THE DESERT IN THE 1930S**

L. Leakey's (1954) first journey across East Africa to Olduvai Gorge, Tanzania, was an epic scientific adventure, leading ultimately to a huge personal scientific triumph for both Leakey and his wife Mary. East Africa was a much wilder place then, and he made the arduous journey in an old truck across jagged mountains and gorges where roads barely existed. Leakey bet his fellow scientists he would find tools there before he even got to the gorge. He won that bet on the first day and soon found the Oldowan stone tools that were later to propel him to worldwide fame.

Incredibly, in that exact same year of Leakey's epic journey across Africa -- 1931 -- at the American Association for the Advancement of Science convention held in Pasadena, California, Blackwelder (1933), unhappy with basic geological dogma of his day, issued a plea for new investigations into the processes of the exfoliation of desert rocks. In response to that plea, sometime later in the early 1930s, Laudermilk and Kennard (1938) designed a desert experiment to test the possibility that lightning could produce some rock exfoliation. They initiated a study within a well-defined California desert township, 10N., R.2E., S.B.B.M., located about 11 km east of Yermo, California, where they had seen abundant rock breakage and where the higher ridges were known to attract lightning strikes. They noted that lightning always sought out the highest point in the landscape, and in the treeless desert, that would be the ridge-top rocks. They wrote: "When one walks over the ridges, one finds flakes and spalls in great abundance. They lie commonly in more or less circular areas, which may have a radius of anywhere from a foot to as much as 5 feet" (Laudermilk and Kennard 1938).

California desert pavements commonly exhibit two types of lithic scatters: some are easily recognized as prehistoric scatters (Figure 2), while other clusters show no sign of the retouching expected from human manufacturing, and these appear to result from natural causes (Figure 3). The authors reported both types on the ridges. They set out to prove their point as well as providing a method to distinguish lightning spalls from lithic workshop debris. They collected large, unmodified cobbles from the ridge tops and took them to the high-tension lab at Caltech, where artificial lightning strokes applied to one rock successfully struck off a spall similar to spalls they observed in the field which they felt were lightning spalls (Figure 4). Without realizing it, they had designed a successful experiment that demonstrated that lightning could produce lenticular spalls that bore resemblance in form to flakes of the Oldowan industry in East Africa, which was at that time in its early stages of study. A bizarre concept indeed, but the authors were successful in their attempt.

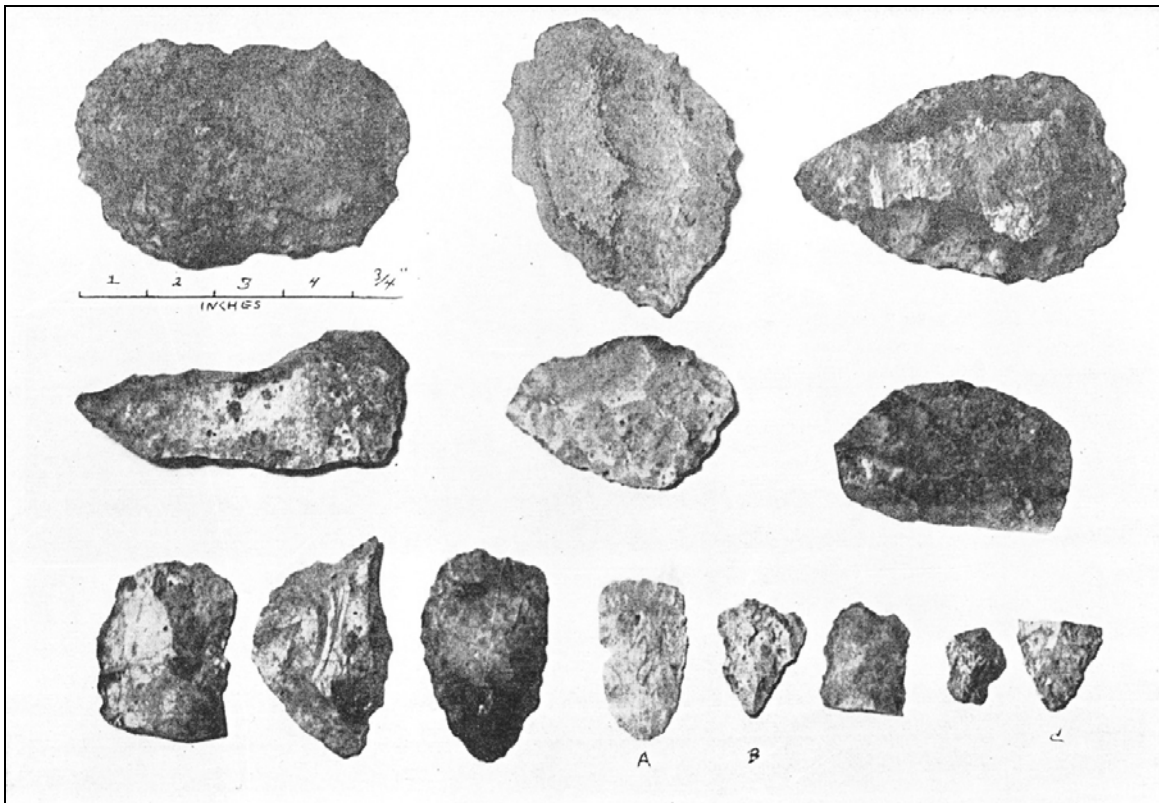


Figure 2. This is Figure 1, from the 1930s study. Text reads: "Flakes and spalls from the first type of the Yermo locality. These specimens are all retouched and obviously artifacts. With the exception of specimens A, B, and C, which are from the Mohave river. These are typical examples of the types occurring abundantly on the ridges." The top six are distinct Manix Lake lithic industry types, the type Simpson later took to London where Leakey, when he saw them, immediately responded, "Where'd you find these? They're Achulean." (The Manix Lake industry should not be confused with the subsurface Calico Early Man industry; both are present on the same site. The defining features of the Manix Lake surface specimens were the similarity of the specimens to the Coup-de-poing in Europe, their degree of desert varnish, the fact that they are embedded in the pavement, and proximity to Pleistocene Lake Manix. The subsurface Calico Early Man industry was considered an earlier, cruder industry than the Manix Lake industry.)

Laudermilk and Kennard observed simultaneous stresses in the impacted rock, first when the stream of electrons enters the rock and the second kickback when it leaves. These are of almost equal force, and two bulbs of percussion may result; nothing solid hit the object, but still breakage without fusion occurred, believed caused by localized high-temperature heating over an extremely short period of time. It was noted that bulbs of percussion and lenticular flakes -- both defining features of lithic manufacturing debris -- were produced. The results were published in 1938, along with criteria designed to help distinguish lightning spalls from lithic workshop debris also found at the site (Laudermilk and Kennard 1938). Like the belated discovery of Gregor Mendel's long-ignored work which carried implications for future work, this prescient paper has languished in complete obscurity until I stumbled upon it recently in the basement archives of the Long Beach public library.

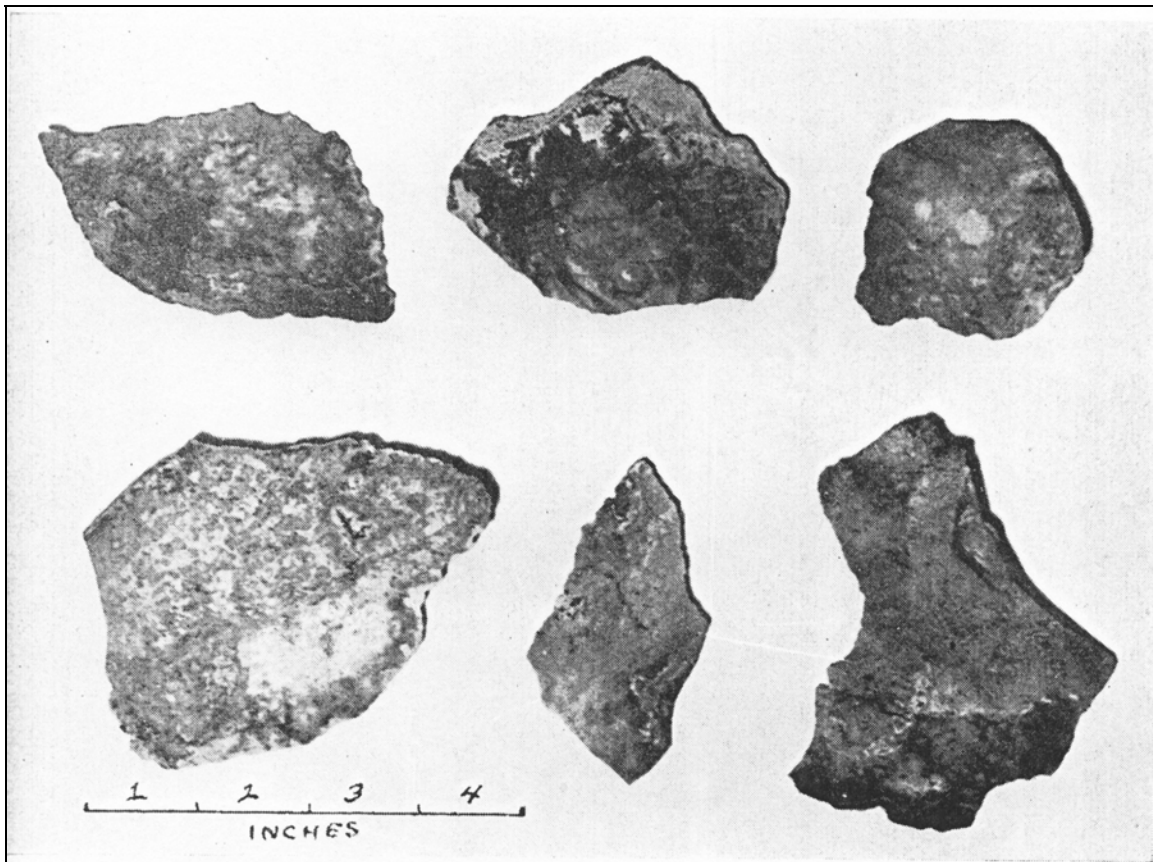
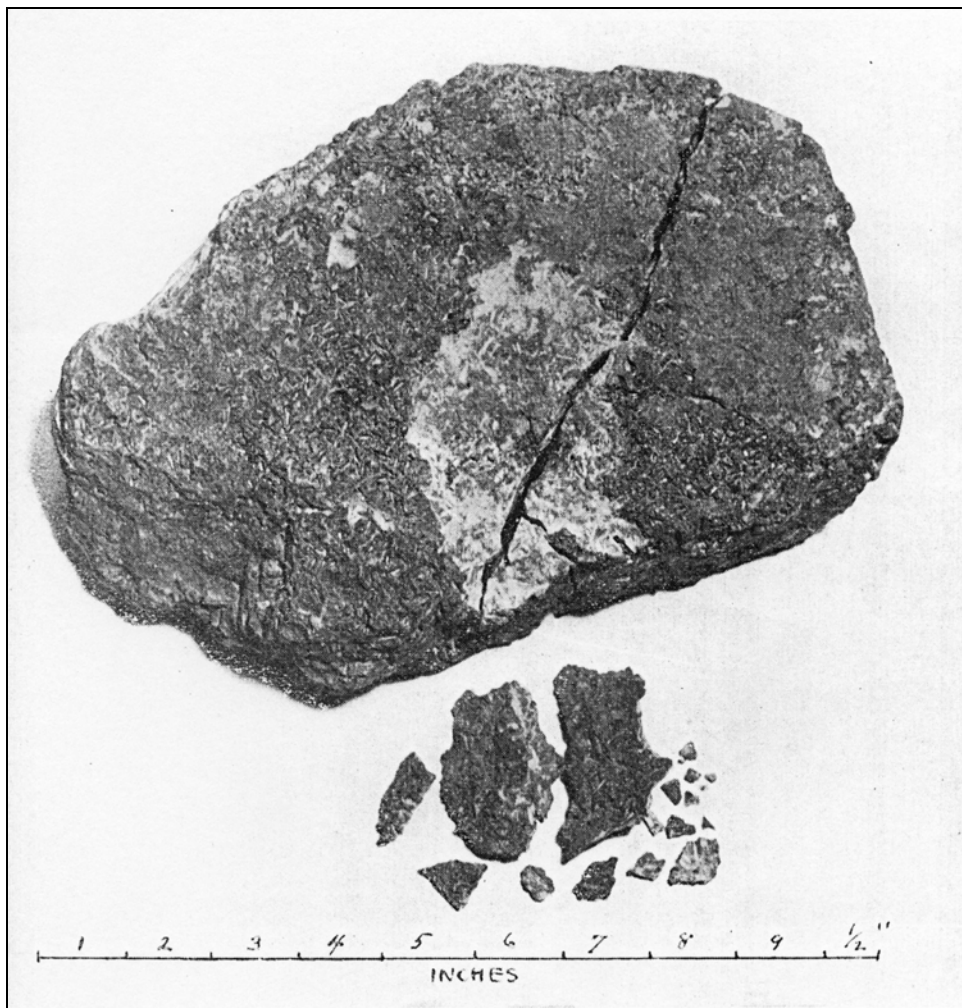


Figure 3. This is figure 6 from the 1938 lightning spall study publication. The 1938 text reads: “Flakes of the second type. While apparently well-adapted as primitive implements, these appear to be crude spalls and show no indication of retouching.”

### LEAKEY AND SIMPSON IN THE DESERT IN THE 1960S

Throughout the twentieth century, European archaeology was dominated by the dogmatic supposition that variation of crudeness in stone tools (typologies) could be used to date archaeological sites. The cruder the implements, the older the site. The grade types in one scheme went from most crude, Chellian, through St. Acheul I, St. Acheul II, Mousterian, and finally the most elegant being Magdalenian, each supposed to be a completely separate era in artifact styles (Pitts and Roberts 1997:116). Simpson and colleagues tried to apply the same Old World graded typologies system to the American west, and in 1942 Simpson was brought to Calico when a colleague brought her unusual “primitive tools” he thought bore the marks of Early Man. Simpson came away with these impressions of the tool types found in the area. She wrote: “The Calico Mountains survey was actually a pilot project in the Mojave desert. It dealt with specimens which in the 1950s were not generally accepted as tools” (Simpson 1998:18). Earlier, She had written: “The first discovery of artefacts earlier than those mentioned, came from a vast workshop covering the 1951-foot high ridge ... Here were found, in 1956, many large scrappers, several choppers and a few crude, boldly-flaked biface and uniface core implements similar in form to the pre-Chellian *coup-de-poing* of Western Europe and Africa” (Simpson 1958:4).

In 1958 she took samples of the collected specimens to Leakey in London where she interested Leakey. “When Leakey, who had promised her five minutes in his very busy schedule, saw the tools he



*Figure 4. This is rock seven from the 1938 study from which an artificial lightning strike successfully split the rock and produced the two lenticular flakes you see in the photo.*

said ‘where’d you find these? They’re Achulean’” (Clouse and Clouse 2000:9). She of course had unwittingly collected them from precisely the 1930s Laudermilk and Kennard lightning spall study site. It should be noted that the Manix Lake surface specimens she took to Leakey did indeed resemble Acheulean precursors, but others (Wallace 1962:172) saw them as New World Holocene quarry samples. Leakey soon joined Simpson in California and, assessing the study site, chose a ridgeline, pointed to the ground, and was later to write: “...I told her, this is where we are going to excavate, not right there on the cut, but just behind it. This to me is a site --- an archaeological site within a geological formation” (Leakey 1972:11). He had chosen section 22, T.10N., R.2E. S.B.B.M. (Simpson 1999:9), precisely within Laudermilk and Kennard’s 1930s published lightning spall study area (Laudermilk and Kennard 1938:104). The odds on this happenstance are probably greater than on winning the lottery.

Simpson and Leakey soon encountered what they argued were pre-Clovis specimens in the Calico sediments then dated to about 50,000 years ago (Leakey et al. 1968). These claims, published in *Science*, immediately became controversial. In 1970, an international conference of prehistorians was convened at Calico with the intent of resolving the issue, and the consensus went against Leakey (Dixon 1988). Later Haynes, also in *Science*, hypothesized that the disputed Calico specimens were most likely “geofacts” produced by geological tumbling in a Pleistocene landslide system (Haynes (1973). Amazingly, through

all this no one realized the earlier 1938 publication even existed. It should be noted that in 1963 Simpson's work was well thought out, aggressive, professional archaeology and had the enthusiastic support of many top Great Basin archaeologists.

## CROCODILES AND WETLANDS ENVIRONMENTS

In East Africa in 1954, L. Leakey (1954:66) claimed to have found in the Olduvai Gorge sediments then dated to about 400,000 years ago, no fewer than 12 well-defined stages of the hand axe culture, ranging from crude early stages through much superior later stages. Then later in 1964, with Bed I redated to 1.8 million years before present and the discovery of a new hominid *H. habilis* associated with the artefacts, M. Leakey (1971) proposed that the stages initially perceived by L. Leakey as a continuum were more reasonably explained as a kit of hominid-made tools, each type designed for a separate utilitarian purpose. She separated these kits into two stages: "Oldowan" in Bed I, and the slightly more sophisticated "developed Oldowan," made up mostly of spheroids, polyhedrons, and flakes from the lower levels of Bed II. The ability to manufacture tool kits was considered evidence of a considerable leap in advanced neural circuitry of the supposed maker of the toolkit, *H. habilis* (Ambrose 2001:1748). Toth (1985:114) later reassessed M. Leakey's interpretations, categorizing the spheroids and polyhedrons as mere hammer stones, leaving only the flakes as true butchering tools of the Oldowan industry. This reassessment is now widely accepted (Tattersal 1998:128).

The Oldowan industry is based on a single, decisive criterion: provenience, and provenience alone. The argument is that any stones found in the stone-free sands had to have been moved from distant river beds by some unknown animal "transporter" whom high science has concluded could only be *H. habilis*. Without provenience, the Oldowan tools are just common stones. Two million years ago, three species of crocodiles ranged in the lower levels of Olduvai Gorge, among them the Nile Crocodile (*Crocodilus niloticus*) (Leakey 1971:291).

The crocodile is an indisputable and far more likely transporter of utterly common river stones and was most certain to have transported them in immense numbers along river and lake shores over the many millennia the crocodile was known to range in the lower sediments of Olduvai Gorge 1.8 million years ago. Crocodiles begin life as lizard-sized babies and sometimes grow to as much as 1,000 kg. That's 10 kg of rocks in its stomach at all times. The crocodile has ranged across East Africa for over 200 million years. Time enough for them to have produced billions, more probably trillions, of stomach stones, virtually all of them still intact somewhere to this day. All of them indistinguishable from tools of the Oldowan industry. All of them along relict river and lake shores, for that is the only environment where the crocodile can survive. River and lake shores are the only environment in which the identical Oldowan industry stone tools have been found so far.

A second, less decisive supporting argument has long been that broken and cut-marked bone fragments are often found along with the stones, and many these bone fragments bear cut marks presumed to be evidence of early hominid butchering or scavenging activity. A crocodile's bite can easily crush a man's arm. Crushed and cut-marked bones are exactly what you might expect on bone fragments that have been torn violently from a victim's torso, eaten and then crunched in a crocodile's energetic stone-filled stomach, and later regurgitated out onto the soft riverside sands along with the stomach stones.

Using contemporary mtDNA and Y-chromosome variation as a clock, geneticists have calculated that modern humans dispersed into greater central Asia by 40,000 years ago (Goebel et al. 2008). Using the same mtDNA and Y-chromosome study methods, geneticists have calculated the time of the split of the groups that entered the New World from the Central Asian mother group as between 15,000 and 22,000 years ago. The sediments at Calico from which the Calico implements have been recovered have been dated to 80,000 years ago at the surface to 200,000-220,000 years ago at the bottom (Budinger 2004). What becomes clear is that there cannot have been any human populations in the New World before 40,000 years ago.

The debate is now over. These recent mtDNA and Y-chromosome studies have belatedly slammed the door on all Calico interpretations. Any stone from the Calico sediments now becomes an indisputable geofact. Eighty thousand years ago (the youngest age of the sediments) there were no humans around to manufacture them. This becomes an important point when comparing the Oldowan industry to the Calico Early Man industry which bears some degree of similarity.

With the flakes established as the primary tools of the Oldowan industry, Toth built his arguments in support of them upon the following technological attributes. He wrote:

A six type system of classification was employed to document which stages of flaking were represented in flaking experiments and at archaeological sites.... This system was based on the presence, partial absence, or total absence of cortex on the dorsal surface of the flake, and on the presence or absence of cortex on the platform...of the flake.... In general, percentages of completely non-cortical flakes...tend to represent later stages of reduction of Oldowan cores [Toth 1985:114].

Simpson made nearly identical technical arguments for the now definitively impossible Calico Early Man flakes. She wrote: "Remnant multiple facets on dorsal faces...indicate prior flake removals from a core, which is more indicative of human flaking than natural fractures. Random natural forces are not likely to remove many flakes from a single core.... In Calico assemblages most of the flakes have multifaceted dorsal faces, and a high percentage have no remaining cortex on dorsal surfaces (Simpson et al 1981:5).

At Calico the age of a specimen can be no older than the mitochondrial cap. At Olduvai Gorge the identical specimen --- no matter how old --- can be a tool as long as there was a hominid around to manufacture it. L. Leakey was responsible for hundreds of interpretations at Calico with which he recreated the entire Oldowan tool kit, including flakes, hand axe precursors, polyhedrons, and near-perfect spheroids (Simpson 1999). At Calico, Leakey unwittingly demonstrated that a number of natural events are capable of producing the entire Oldowan kit without hominid assistance of any kind.

### **THE OLDOWAN FLAKES AS ZOOFACETS**

Fitch-Snyder and Lance (1993) at the San Diego Center for Reproduction of Endangered Species studied two alligator hatchlings in a glass aquarium. They were fed once or twice weekly with whole baby mice and pieces of adult mice. They first swallowed stones at about six months of age. After feeding on large portions of adult mice and carrying them into water to consume, they climbed back onto the gravel substrate. Both alligators began turning their heads in a sidewise motion with their jaws partly open and used their snouts as a shovel to loosen gravel. They methodically began picking up small stones with their mouths and selected specific stones to swallow. Several dolomite rocks with rougher edges were picked up and rejected. But smoother-edged pebbles were chosen and repositioned to the back of their mouths by thrusting their heads in an upward motion. Radiographs confirmed these pebbles were carried into the water and swallowed.

Brazaitis (2003) demonstrated that crocodiles regurgitate as well as swallow stones to adjust for weight gain as they grow older. It takes a wild crocodile three years to reach a length of 1.5 m, and they often far exceed this size, weighing as much 1,000 kg (1 ton) in later life. Crocodiles at Olduvai clearly would have moved stones around like musical chairs, constantly swallowing and regurgitating stones and bone fragments into the soft volcanic sands of their riverside basking sites. This constant adjusting for weight from a very early age would produce a significant range of stones of all sizes at Oldowan river sides, and that is exactly the described configurations of the published Oldowan camps (Leakey 1971).

All current thinking on the origin of the human mind today starts with the Oldowan flake (Ambrose 2001:1748). As of now, only flakes are viewed as the working tools of the Oldowan industry (Toth 1985:128). Recent experimental work by Lopinot and Ray involving elephant and bison trampling in the American west might shed a different light on the far distant East African flakes. These experimenters working in the American west were faced with the problem of differentiating natural from cultural pre-Clovis proto-tool specimens that could be either natural geofacts or cultural flakes of the



Clovis culture of North America. Experiments were undertaken to evaluate a natural versus cultural origin for a set of modified pebbles and cobbles found in a pre-Clovis-age complex at the big eddy site (23CE426) in southwest Missouri. They were uncovered in a provenience that met the probable interface of the Clovis era of about 14,000 or 15,000 years ago. Were they geofacts or artifacts? It was hard to tell.

The investigators suspected the pre-Clovis specimens were not artifacts but were formed by trampling of large mammals visiting the site repeatedly during the Pleistocene (Lopinot and Ray 2007). Given that mastodons were present when the late Pleistocene deposits were formed, they decided to use Asian elephants as a proxy for the mastodons and created a replicative trampling experiment. The experiment involved approximately 4,333 pebbles and cobbles collected from the Big Eddy river gravels. These specimens were closely inspected to insure none were flaked or otherwise modified, then placed in a hand-excavated, plastic-lined pit measuring 1.5 m in length, 1.0 m in width, and 6-8 cm in depth. Two elephants in tandem, led by handlers, trod over the gravel a total of 50 times, with two feet of the elephant normally hitting the gravel with each round. After this, it was found that 232 flakes and 40 angular fragments were produced. These experimentally modified flakes were remarkably similar to the flake specimens found in the pre-Clovis-age deposits (Figures 5-7).

Hippos and crocodiles live and die together, glued to the water's edge. The modern hippopotamus is the world's third largest animal, the male weighing up to 4,000 kg. Leakey reported even larger hippopotamuses at Olduvai: "As might be expected in deposits which were formed mainly in a shallow lake, remains of hippopotamuses are very common in the Gorge. Two extinct species of them have shown up. One, *Hippopotamus gorgops*, was much larger than the hippopotamus of today..." (Leakey 1954:69).

The hippo spends most of its daylight hours wallowing in shallow water, then coming out of the water in the evening for a night of riverside grazing. In some parts of Africa, hippos trample riverbanks and lakeshores, creating a maze of waterside paths and wallows that they use to get access to the plants they eat. During the dry season, when lakes and rivers shrink, hundreds of hippos sometimes congregate in closely packed herds. If three Asian elephants in Missouri today can easily produce proto-flakes simply by stepping upon a small test pit 50 times, it becomes reasonable to expect large herds of hippos to produce immense numbers over the many eons they've been around. The hippo's constant companion, the crocodile, would happily swallow many of these zoofacts, inevitably transporting them to many diverse basking sites. The hippopotamus makes the perfect riverside zoofact manufacturer; the crocodile, the perfect transporter. They have shared the same riverside sites in harmony for possibly as much as 50 million years. Plenty of time for them to cooperatively to have transported immense numbers of zoofacts. It now becomes difficult if not impossible to accept any Oldowan stone tool, core, manuport, flake, debitage or cut-marked bone fragment as anything other than mere crocodile excreta. Evolutionary-thinking anthropologists -- California or otherwise -- thinking in terms of "tool making," "home base," "scavenging," "food sharing," etc., might want to keep the above probabilities in mind.

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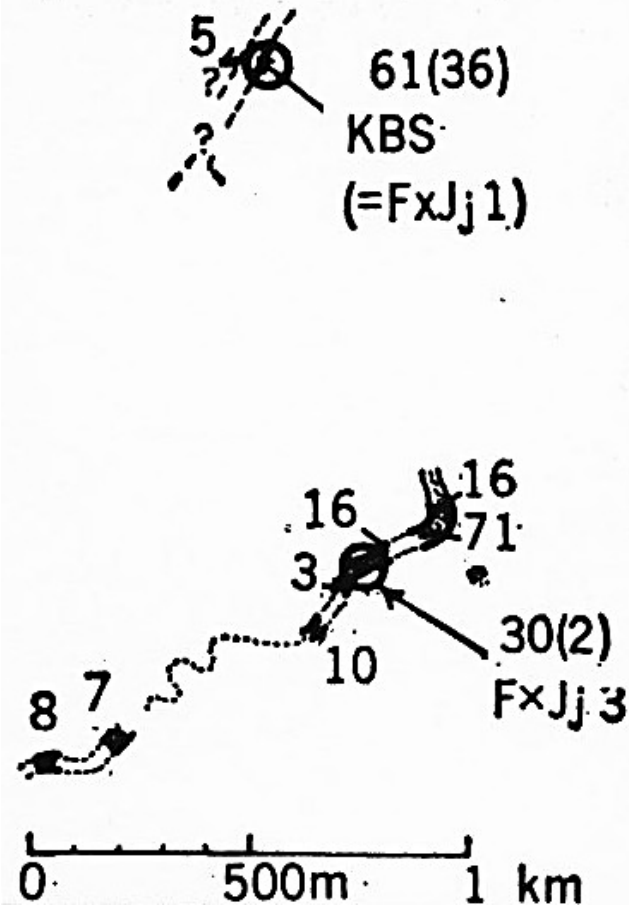


Figure 5. This is a detail from a larger map published in *Science* in 1971 (Isaac et al. 1971:1129-1134). The double lines denote the edges of two exposed meandering stream channels filled with 2-million-year-old volcanic tuff. Numbers denote stones collected that season. You can see that all stones were collected from beach sands precisely within the ancient beach channels. Two crocodylians, *Crocodylianus niloticus* (Nile crocodile) and *Euthecodon brumpi*, are known from several complete specimens retrieved there (Maglio 1971:249). Both crocodiles would almost certainly have left gastroliths on the same beach sands the stone tools were recovered from. The numbers not in parentheses denote surface finds -- those in parenthesis were recovered in situ from excavations. The large circles are specific site names. KBS stands for Anna K. (Kay) Behrensmeyer Site. This is the site that was the inspiration for Isaac's home base theory described in the same issue of *Science* in 1971 in which he wrote:

"Occupation sites containing stone artifacts and introduced, broken-up bones probably imply significant evolutionary intensification of certain behavioral characteristics, which may occur sporadically in nonhuman

primates but which become especially prominent characteristics of Pleistocene Hominidae. These are manufacture of tools, hunting or scavenging (or both), food sharing, and organization of movements around an archaeological home base" (Isaac et al. 1971:1133).

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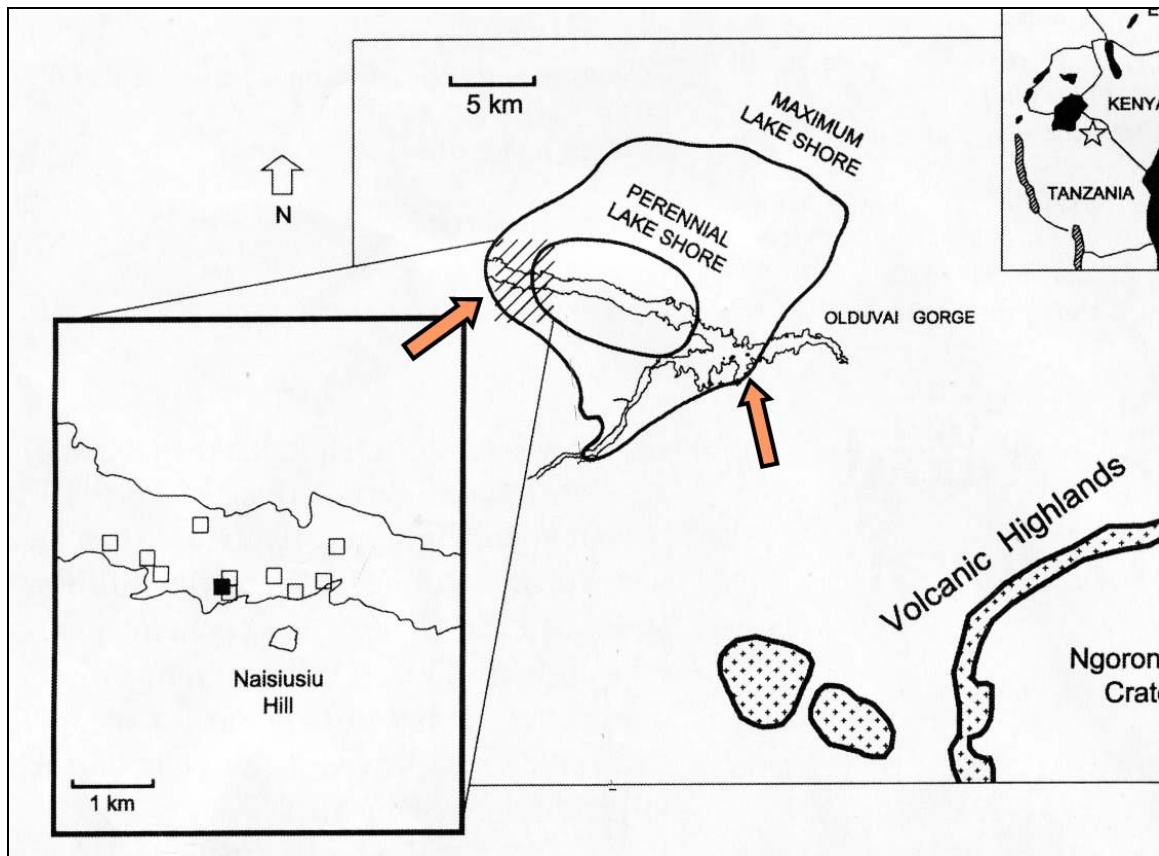


Figure 6. Detail from a larger map published in *Science* (Blumenschine et al. 2003:1218) showing the minimum and maximum levels of the lake shore at Olduvai Gorge 1.8 million years ago superimposed upon the map of Olduvai Gorge as it is today. The squares indicate 11 trenches that produced tools. The trench indicated by the black square produced a hominid. Streams flow into the lake along the red arrows (Hay 1971:16) (arrows were added by this author). Oldowan sites are limited almost exclusively to the perennial lakeshore areas pointed out by the arrows. Fossil evidence of both crocodiles and hippos was found in those streams (Hay 1971:15). Mary Leakey (1971:291) listed three species of crocodiles in these same areas.

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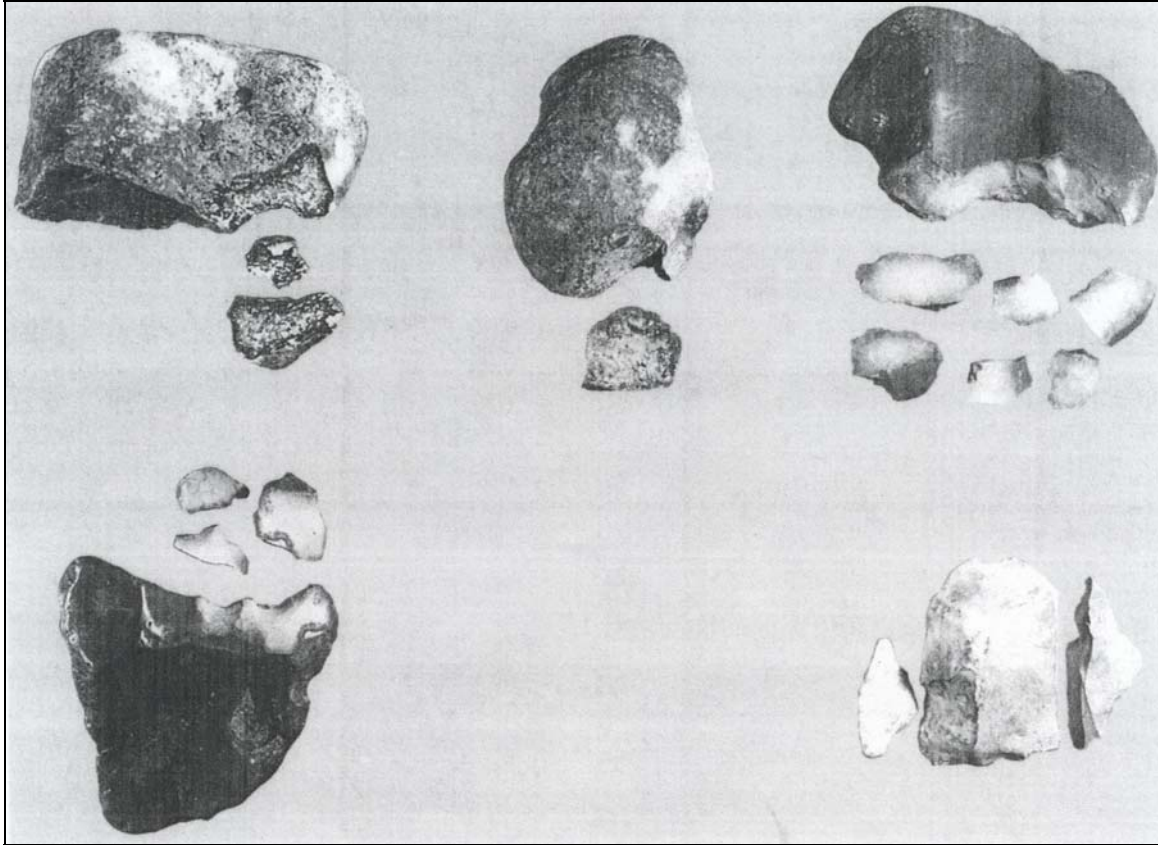


Figure 7. Flakes and cores produced in an Asian elephant trampling experiment similar in every way to flakes and cores of the Oldowan industry of East Africa.

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