Paleontology by Bulldozer

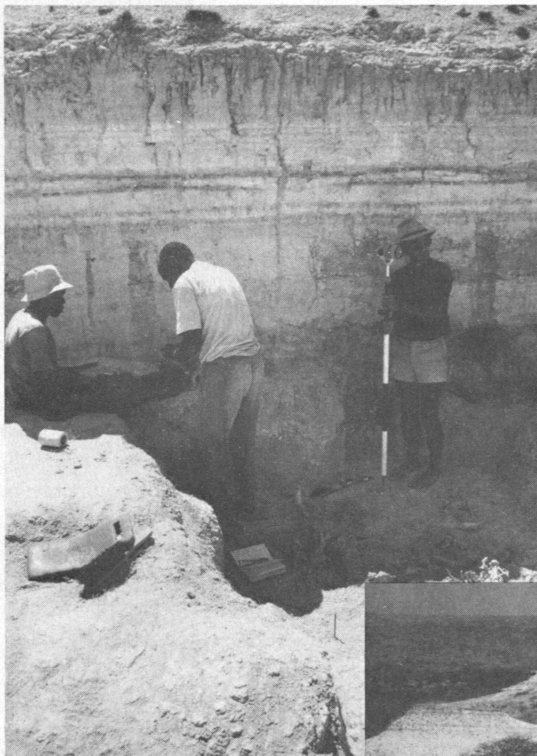
Practicing a novel approach to the African dig—landscape archeology—Richard Potts is not hunting for the next Lucy but is trying to reconstruct an ancient world

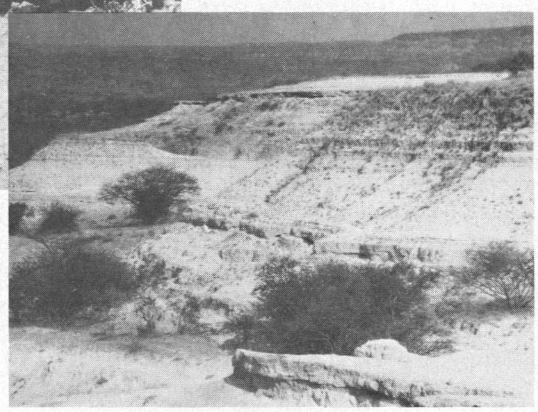
An hour south of Nairobi, in Kenya's Great Rift Valley, Richard Potts has been digging trenches in the steep, sun-bleached banks of a Pleistocene lake. Standing in the lake bed, looking up at the outcropping where his team has been working, Potts points to a distinct brown line that cuts across the wall of otherwise white dirt. The layer of soil is only 3 inches wide, but it is Potts' guide to excavating the site. Says Potts, who is an associate curator of anthropology at the Smithsonian Institution in Washington, D.C.: "This ribbon of sediment is a window into the ancient landscape."

By following the thin brown line, Potts has become one of the first anthropologists to try an ambitious new approach to unearthing the past. For years, scientists have followed a trail of bones—or of stone tools— that are scattered across the surface of sites the size of a room or two. Once they find what they want, they move on to another site. Indiana University anthropology professor Nicholas Toth calls it "going for the goodies."

But Potts is in the vanguard of a group of paleoanthropologists who want far more than bones and artifacts. They're interested in reconstructing ancient worlds—the weather, the plant life, and the wildlife that thrived at a given site. How all those factors affected the behavior of hominids is only one—albeit, their central—question. "We're not just out there fossil-hunting but doing the in-depth ecology and detective work to find out what in the world these hominids were doing," says Potts.

How do you reconstruct an ancient world? With a bulldozer and $50,000 per year. Potts has both and has chosen to inspect a ribbon of fossil soil about 1 million years old. The site is Olorgesailie, a Kenya national monument famous for its early Acheulean hand axes. There, for 4 years, Potts and a crew of 16 have dug 20 trenches and literally bulldozed a hilltop. Like miners tapping a vein, the Potts team digs to the level of exposed brown paleosol and analyzes everything that's there. Eventually, the team will dig trenches the entire length of the 3-mile site. "I want to get away from isolated sites, which are a very small window into the past," says Potts, 36, his khaki clothes and Indiana Jones hat covered with chalky white dust churned up by the work. "What we've done now is let the sediments—not the bones or a hand ax—be our guide."





Landscape archeologists. *Two Kenyan excavators and the Smithsonian's Richard Potts (who is holding a prism pole to record the spatial coordinates of new-found artifacts) are unearthing a million-year-old hyena den on the steep flank of the Olorgesailie outcrop (shown below). They're after not just hominid bones, but clues to ancient weather, flora, and fauna.*

It's an ambitious method that is surprisingly uncontroversial, despite the fact that it can be time consuming, labor intensive, and costly. Calls to ten leading anthropologists found all in support of Potts' work, and most predict that more will try the same approach—if they can find funding and the right sites. In fact, the only apparent Achilles' heel of Potts' attack on Olorgesailie is one that concerns traditional anthropologists as well, but for which traditionalists have more protection: the accuracy of physical dating.

The classical approach begins with a discovered artifact—one that may well fit into a well-established time scheme based on, say, the relative sophistication of the artifact or the conformation of the body part. Thus, the anthropologist begins with an approximate date and uses modern physical dating methods to confirm that date—or throw it into doubt.

But Potts isn't starting with artifacts. He's starting with nothing more than a ribbon of brown soil that new argon laser fusion studies by Alan Deino at Berkeley's Geochronology Center at the Institute of Human Origins indicate to have been laid down at Olorgesailie about 980,000 years ago (give or take a few thousand years). And yet the outcrop itself includes one of the broadest time spans for any site in Africa—from 49,000 to 992,000 years ago.

Independent paleomagnetic reversal studies by Lisa Tauxe of the Scripps Institution of Oceanography may provide an independent calibration of the dates of Potts' dig. But Tim White, a UC at Berkeley anthro-

Potts on landscape archeology:

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pologist, expresses the one caveat *Science* has heard about this work: Its only "danger," he says, "is the degree to which investigators can establish that the remains—paleontological, flora, and fauna—are species that lived at the same time. The Geochronology Lab gives you the best dates in the world, but these are still blurry snapshots of the past."

But there are limitations to classic paleoanthropology as well—limitations that led the late Glynn Isaac, a University of California at Berkeley anthropologist, to propose what many feel was the formative idea behind Potts' work. Isaac was working at Koobi Fora on the east side of Lake Turkana, Kenya, in the 1970s. He was bothered that archeologists were focusing their efforts on the most dramatic concentrations of bones and stones. Wouldn't that give them an incomplete picture of hominid activity at the site? he asked. Isaac proposed instead that his team look at the isolated bones and stones lying on the surface between the rich sites—an approach he called looking for the "scatter between the patches."

At about the same time, Lewis Binford of the University of New Mexico gave the novel approach its name: "landscape archeology." Binford proposed that any concentration of fossil riches should be put in context with the rest of the landscape. First, researchers should decide whether it was nature or hominids that created the deposits of bones and tools. "If you find a localization of stuff and have no idea about the system of which it's a component, it's like you're looking at an elephant through its toenail," Binford told *Science*.

But neither Binford nor Isaac was able to try the landscape approach at ancient sites in Africa. Isaac died suddenly of illness in 1985; Binford couldn't get funding. Then, perhaps because more recent, paleo-Indian sites in the American Southwest have been more accessible, several anthropologists (notably Eileen Johnson, curator of anthropology at Texas Tech University, and Cynthia Irwin-Williams at the University of Nevada) began to explore the new method. But Potts became the first to use landscape archeology to study early hominids.

In 1988, armed with the backing of the National Museums of Kenya, Potts convinced the Smithsonian to grant him $50,000 a year for his work at Olorgesailie. He had been deeply influenced by Isaac, with whom he had worked briefly as a Harvard University graduate student at Koobi Fora, and he wanted to expand on what he had learned there and at a dig at Olduvai in Tanzania.

But what Potts proposed to the Smithsonian was different from what Isaac had done in one extremely important sense: Isaac had scoured the surface; he wanted to dig deep. "I was worried that things you find on the surface are not necessarily indicative of what's in the ground," explains Potts.

Olorgesailie was one of the few sites where the geology was ideal for this approach—erosion had exposed a datable line that extended for almost 3 miles along the lake margin. All you had to do was get down to the line. So Potts reversed nature's handiwork last summer by using a bulldozer to raze a hilltop, removing 12 feet of unfossiliferous diatomite sediments. This summer, his team will resume the painstaking work of sifting through the fine silt for everything from bones, stones, and artifacts to pollen, seeds, insects, and bats.

What Potts wants is a good glimpse of one of the most interesting and least understood periods of human evolution—the mid-Pleistocene when *Homo erectus* probably roamed the region and had begun its expansion into Asia and other parts of the world. It was a large-brained species that lived 300,000 to 1.7 million years ago, intermediate between the first upright walking humans and modern *Homo sapiens*.

But the mystery of Olorgesailie is that the skeletal remains of this early human never have been found at the site—despite years of intensive excavation by Louis and Mary Leakey in the 1940s and Isaac in the 1960s. As a result, little is known about the behavior of this being whose characteristic hand axes litter the site.

To date, there have been many theories about *Homo erectus*, but Potts says there is little basis in the bones discovered at other sites for many of the human traits ascribed to these creatures. Anthropologists have long thought that once hominids stood upright, they acted human—walking on two legs, using tools, hunting for meat, and forming nuclear families. A new view, however, is that those traits developed over a few million years. "Now we're beginning to see that hominids didn't have all these features at the beginning of evolution," says Potts.

Potts on our ancestors:

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"They were these odd creatures that weren't quite like us, maybe sleeping in trees and acting more like apes. We have to try to understand hominids in their own terms, and we can't assume they were little or primitive versions of ourselves, but creatures in their own right."

As Potts' team tries to reconstruct the world of *Homo erectus*, he takes a three-step approach. First, he studied the site taphonomy. Were the fossil bones and stone tools left in clusters by hominids or were they deposited by rapidly moving water or wild animals? After excavating 120 square yards of paleosol, he found two main areas where hominids left dense collections of fossil bones and tools. At one site, the team found the nearly complete skeleton of an elephant whose bones are intermingled with stone tools. Potts thinks he has uncovered an animal butchery site where the early hominids carved up a large carcass for meat.

Having established the presence of hominids, step two was to figure out what the sites reveal about patterns of early human behavior. How did they acquire food? Did they hunt or scavenge? How did they make tools and what materials did they use? Were the tools kept in stone caches near the areas where they butchered carcasses? Did they carry primitive "tool kits" large distances and were they able to move over wide areas in their hunt for food? If so, does it mean they could plan ahead and shape fairly sophisticated strategies? Did they share their food? And most important, could they control fire and set up campsites where they kept predators at bay?

Potts' theory is that these hominids did have home bases where they could protect their young and old—something their earlier ancestors at Olduvai could not do. The team has found bones scarred by stone tool marks, according to analysis with a scanning electron microscope. This is unlike bones found at Olduvai that have both stone tool marks and carnivore teeth marks—indicating that the hominids shared the carcasses with large cats and hyenas and were not able to keep them away from their bases.

Potts also is looking to the ancient environment to shed light on hominid activity. Fossilized seeds and pollen should help him determine what the climate was like and how it affected the seasonal supply of food and water, keys to hominid migration. And he wants to know how hominids used the local resources. What kind of plants and animals were available for food and other uses? Already, it seems that the freshwater lake was a factor in their choice of campsites. Potts points out that these are not questions that can be answered by studying *Homo erectus* skeletal remains. "It's not just finding hominids that's important," Potts says. "Everyone's trying that—looking for hominids but ignoring the context. What we're trying to do is look at the context. If hominids come with it, fine."

Potts has been surprised by some of the answers he's getting. He found more equids (particularly zebras) living at Olorgesailie 1 million years ago than antelope and other bovids—an unusual mix of species not previously noted in the fossil record. He wonders if environmental change could have affected the proportion of these species and caused behavioral changes in hominids. For example, what kind of ecosystem would have allowed some species of plants and animals to thrive, while others did not?

And then there's his last and most complicated goal—understanding how the early hominids' behavior affected their own evolution. For instance, what social strategies and other behavior would have given early *Homo* an evolutionary edge over the last of the australopithecines? "If we're trying to understand the shifts from our more apelike ancestors to more modern hunter-gatherers, we have to understand how they were using the landscape," says Potts.

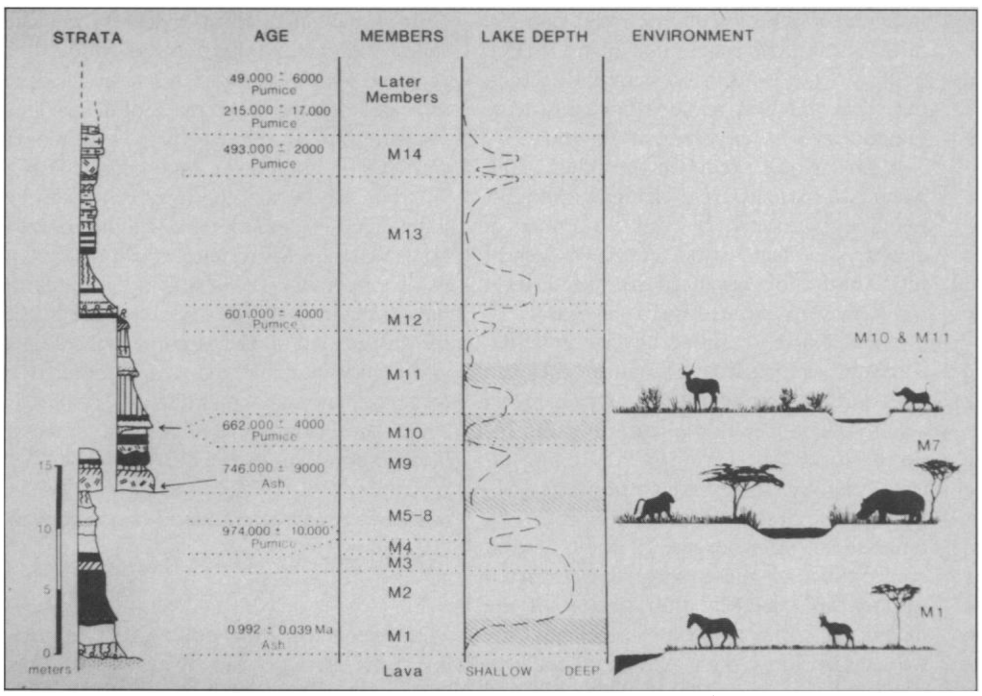
Trying to reconstruct such a complex scene, however, is painstaking, tedious work. "It's worthwhile stressing that a long-term study like this requires a tremendous amount of individual commitment and a substantial amount of continuing support for research," says Clark Howell, a professor of anthropology at UC Berkeley. "This is not a one-man show. It is a multiple team effort that requires the right kind of people."

Potts' team is indeed large, comprised of a half-dozen geologists, led by paleobiologist Kay Behrensmeyer, who study everything from the stratigraphy of the site to what kind of volcanic materials were used to make tools. Last summer, they used a Topcon EDM transit that used beams of laser light to map the site with enough precision so that every artifact can be located on a three-dimensional computerized grid of the landscape. Meanwhile, back in the laboratory at the Smithsonian, research assistant Jennifer Clark is using the scanning electron microscope to look for tool and carnivore marks on bones, while biochemist Noreen Tuross is studying bone mineralogy and its organic content for clues about diet and ecosystems. And at the National Museum in Nairobi, still other researchers are examining the fossilized bones of large vertebrates, as well as the seeds and other material collected at the site.

Potts says the team will be at work at Olorgesailie for years. And that's just the beginning. Potts would like to see an international team try the landscape approach at other sites around the world, starting in Asia, to see how *Homo erectus* was behaving 1 million years ago. By comparing hominids living at the same time in different places, anthropologists would learn about the variability in hominid behavior and how differences in the way the hominids used their environment and resources affected their evolution.

Robert Blumenschine at Rutgers University is already trying the landscape approach at an earlier site—1.6 million to 1.7 million years ago, when the first *Homo erectus* was born and when *Homo habilis* and several other species of hominids ranged through the area. Blumenschine started his excavation at Olduvai last summer with 17 small trenches. The National Science Foundation has granted him $100,000 a year for 2 years, and other scientists, such as Jack Harris, also at Rutgers, say they too plan to seek funding to try landscape archeology. "I see it as the way archeology is done in the future for these early time periods," says Blumenschine. And he's supported at the NSF. John Yellen, program director for archeology there, says that if Potts and Blumenschine succeed, many more researchers are sure to try the same road. "I think this really is an up and coming approach," says Yellen, "Rick's work is pathbreaking."

■ **Ann Gibbons**



Age gauge. *Argon laser fusion dating by UC Berkeley's Alan Deino has produced these time strata for the Olorgesailie outcrop. [The lake depth data are courtesy of R. Owen and R. Renault in* Paleoecology of Africa, 1981, *and the fauna shown are based on studies by C. Koch at the University of Nairobi.]*

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