New skulls, dates, and simple stone tools from Georgia reveal traces of people who may have been the first humans to travel outside Africa—a stunning 1.7 million years ago

A Glimpse of Humans' First Journey Out of Africa

TAUTAVEL, FRANCE—One day last May, an archaeology student named Gotcha Kiladze was showing an archaeological site in Dmanisi, Georgia, to a group of visiting schoolchildren. Dmanisi, 85 kilometers southwest of the Georgian capital of Tbilisi, had already yielded a few ancient human bones and stone tools, but outside researchers had been skeptical about their age and which species they represented. Then

on this spring day shortly before the season's excavations were scheduled to begin, the team's luck changed. It had rained heavily in previous days, and suddenly Kiladze spotted the glint of a bone poking out of the sediments. After careful excavation, and to the joy of the team, it turned out to be the skull of an early hominid, apparently a young adult male. Two months later, another student unearthed a second skull, this time what appeared to be a female adolescent, including part of the face and the upper jaw with four teeth.

Kiladze and the rest of the multinational team are now basking in the glow of these discoveries, which are presented on page 1019 of this issue and were also shown off last month at a meeting convened here to explore new evidence about the first Europeans.* The meeting, organized by French prehistorian Henry de Lumley, was something of a coming-out celebration for the Dmanisi fossils, with talk after talk on the skulls, the accompanying stone tools, and their ages. The talks and paper present a startling conclusion: that the Dmanisi humans were at least 1.7 million years old—the most ancient undisputed human fossils outside Africa.

Anthropologists say that the skulls, high-quality casts of which were on display during the meeting, closely resemble hominid crania of about the same age from East Africa. Although researchers have claimed that humans reached the island of Java in Indonesia by this time, the Dmanisi people appear to represent the first known wave of humans who left Africa and then colonized much of the rest of the globe. They are the first hominids with clearly "African" features found outside that continent—and they used only a simple stone tool kit, called Oldowan tools, to accomplish their journey. "They look African," says archaeologist Ofer Bar-Yosef of Harvard University, who has visited Dmanisi several times. "I would give [Dmanisi] the credence of being the oldest known site in Eurasia with Oldowan stone tools."

Fossil treasure. Two human skulls turned up at Dmanisi *(aerial view, top).*

By today's definitions, the site is indeed in what is loosely called "Eurasia," although many European researchers are eager to claim the Dmanisi skulls for their own continent. "This discovery has doubled again the age of humans in Europe, or at least at the gates of Europe," human anatomist Giacomo Giacobini of the University of Turin in Italy told *Science*. Enthused University of Rome paleoanthropologist Giorgio Manzi during a panel discussion: "This is the missing link between Africa, Europe, and Asia!"

Yet it is not at all certain that these early immigrants out of Africa were directly ancestral to the humans found at key European sites such as Atapuerca in Spain, Ceprano in Italy, or Tautavel (see map). The fossil humans at all those sites are at least a million years younger than those at Dmanisi. Rather, many researchers agree that, as the Georgian team proposed in their talks, the people represented by the Dmanisi specimens may have been the forebears of the first humans in Asia, who are thought to have appeared between 1.8 million and about 1 million years ago, depending on which sites are accepted, and who are usually called *Homo erectus*. "Geographically this makes a lot of sense," says paleoanthropologist Peter Andrews of the Natural History Museum in London, who visited Dmanisi last year and saw the skulls. "These are the first hominids of the genus *Homo* outside of Africa, and they are already a third of the way to China."

A question of age

Despite the fanfare the Dmanisi skulls are receiving, for the team that discovered them it is really an old story. In 1991, prehistorians from the Georgia State Museum in Tbilisi, the Georgian National Academy of Sciences, and the Roman-German Central Museum in Mainz, Germany, launched a new round of excavations at the Dmanisi site, which during the 1980s had yielded important remains of ancient plants and animals. At the end of the first season, they discovered a hominid lower

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* The First Inhabitants of Europe, Tautavel, France, 10 to 15 April 2000.

jaw in a layer of lake sediments, just above a deposit of volcanic rock dated to at least 1.8 million years ago (*Science*, 24 January 1992, p. 401). Yet a number of researchers questioned the date, arguing that the jawbone's shape suggested a younger age and that the bone might have been deposited much later than the volcanic layer. Those questions persisted after a human foot bone was found in the same area in 1997.

But in the paper in this issue the team presents new analyses that support an early date. And at Tautavel, Georgia State Museum paleontologist David Lordkipanidze presented their arguments—and appeared to convince most of his audience of the fossils' antiquity. The skulls, jawbone, and foot bone were all found just above the volcanic layer, which has now been dated by three different teams. The first rounds of dating, using the decay of potassium-40 to argon-40, came up with dates ranging from 1.8 million to 2.0 million years ago. The newest round uses a related but even more accurate technique called argon-argon dating and was performed by respected geochronologist Carl Swisher of the Berkeley Geochronology Center in California. Swisher's results put the lower volcanic level at about 1.85 million years ago.

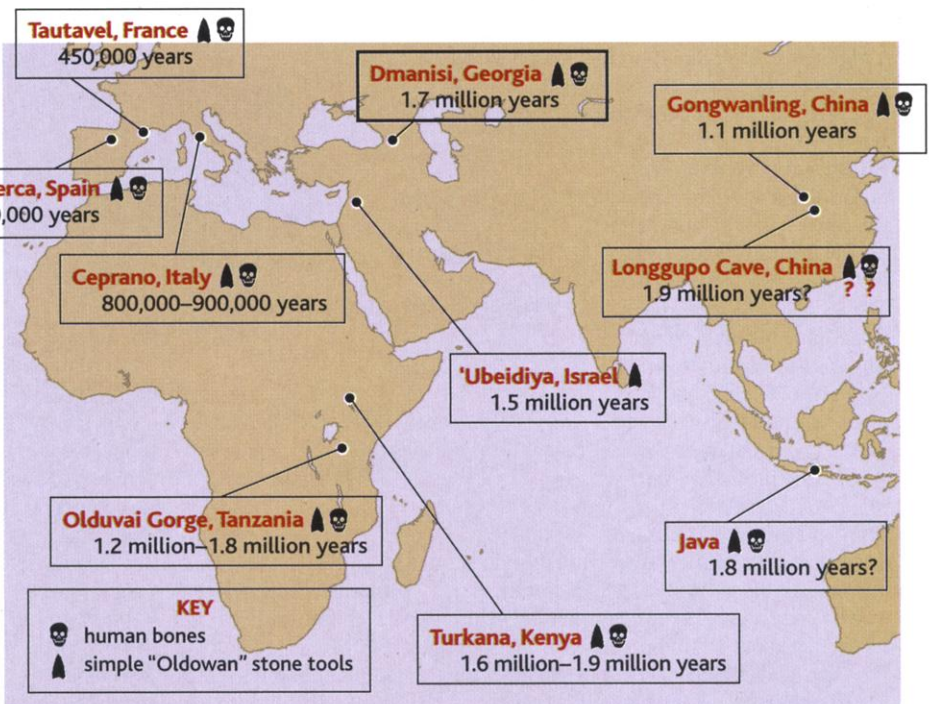
As for the key date of the stratigraphic layer in which the human bones were found, the team argues that it is fixed by new paleomagnetic measurements, which take advantage of known changes in Earth's magnetic polarity, as well as by associated fossils of other species. The team argues that the geology of the site and the bones of other animals show that the hominid-bearing layer was deposited close to a boundary between normal and reverse polarity, known as the Olduvai-Matuyama boundary and well dated elsewhere to 1.77 million years ago. For example, the fossil layer includes teeth from key species of the rodent genus *Mimomys*, known to have lived only between 1.6 million and 2 million years ago, according to unpublished work by paleontologists Jorge Agusti of the Paleontological Institute in Sabadell, Spain, and Aleksander Mouskhelishvili of the Georgia State Museum. "The fauna actually points older—the fauna says Olduvai. And the magnetics say Matuyama, so it's got to be right in between," says Swisher. "I feel confident that we know where the boundary is. I think we're pretty safe and tight."

Christophe Falguères, a geochronologist at the National Museum of Natural History in Paris, told *Science* that the team has "a reasonable argument" in its claim that the skulls are that early. The problem, he said, "is to know how much time has passed" between the formation of the radiometrically dated volcanic layer and the deposition of the fossil-bearing sediments. But Andrews, who says he examined the volcanic layer carefully during his visit to Dmanisi, told *Science* that what he saw was consistent with the claim that the fossil-rich layer was deposited shortly after the underlying volcanic rock had formed. "To me [the volcanic layer] looks extremely fresh," he says, "very ragged and uneven, many sharp edges," suggesting that the rock had not had time to weather before the next layer of sediment was deposited. Taking the dating evidence together, "there is no doubt that humans were living at Dmanisi at least 1.7 million years ago," de Lumley concludes.

Any lingering skepticism about the dates tends to be dispelled by the primitive size and shape of the bones, say those familiar with the new fossils. The skull considered to be an adult male has a braincase of about 780 cubic centimeters (cc), as Leo Gabunia of Georgia's National Academy of Sciences, lead author on the *Science* paper, told a rapt audience at Tautavel; modern humans pack about 1500 cc of brain capacity. The skull of what may be an adolescent female measures about 650 cc. In addition to their small size, the skulls have a number of other features—including high temporal lines, prominent brow ridges, and a marked constriction of skull width behind these ridges—which Gabunia and co-authors argue resemble an early species of human called *H. ergaster*, which lived in Africa between 1.9 million and 1.4 million years ago. (Typical of the lively debate in this field, some researchers do not recognize *H. ergaster* and refer to these specimens as simply early *H. erectus*.) The team has provisionally classified the Dmanisi skulls as *H. ergaster*—the first known representative of this species outside Africa.

After seeing Gabunia's talk or reviewing the new paper, most prehistorians who spoke to *Science* agreed that the Dmanisi fossils closely resemble the *H. ergaster* specimens, including the so-called Nariokotome Boy, an almost complete skeleton of an adolescent male dated to about 1.6 million years ago. For example, paleoanthropologist Alan Walker of Pennsylvania State University, University Park, held a cast of Nariokotome Boy's lower jaw next to the Dmanisi jawbone found in 1991 and concluded that "they look just the same." Andrews says that if the skulls had been found "in an early … African setting, no one would have been surprised." Even many who have seen only photographs are convinced. "They are astonishing!" says Dan Lieberman, a paleoanthropologist at George Washington University in Washington, D.C. "They could be Nariokotome Boy's brother."

But a somewhat more reserved view is taken by Günter Bräuer, a paleoanthropologist at the University of Hamburg in Germany, who had earlier questioned the age of the Dmanisi jawbone. In contrast to Walker, he argued that that specimen more closely resembled later *H. erectus* fossils than early African *H. ergaster*. But given the new dating analyses, Bräuer now says that he sees



Which way? The Dmanisi skulls prove that humans left Africa early—by 1.7 million years ago—but where they went next is still a mystery.

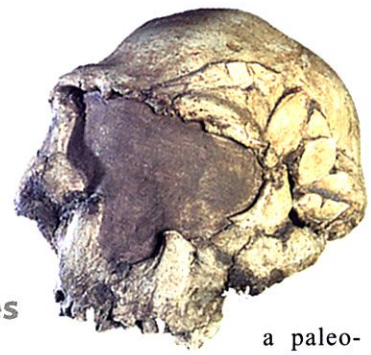
"no reason to doubt" the older date, although he suggests that it should be confirmed by direct dating of a tooth from one of the skulls with another method. He adds that the differences he perceives in the fossils suggest considerable genetic variation in these traits at this time.

If the dating is confirmed, it makes the Dmanisi fossils a rare prize. The skulls are far older than any European fossil—the next oldest hominid from the continent is a crushed skull from Ceprano, Italy, dated at 800,000 to 900,000 years ago. In Asia, a jaw fragment and two worn molars from Longgupo Cave, China, have been dated to 1.9 million years ago, but many researchers aren't sure that the bones are really human (*Science*, 17 November 1995, p. 1116). And Swisher reported argon-argon dates in 1994 that put Java *H. erectus* fossils at 1.8 million years ago (*Science*, 25 February 1994, p. 1118). Those dates have recently come under attack, however, both at the meeting and in a commentary by two Dutch researchers in the April issue of the *Journal of Human Evolution* (*JHE*). The researchers argue that although Swisher probably dated an underlying volcanic layer correctly, the fossils may come from a higher level no more than about 1 million years old. Swisher, however, defends his dates at the Indonesian site of Sangiran as at least as solid as those at Dmanisi, noting that the authors of the *JHE* article never visited the site. He adds that as-yet-unpublished dates support the accuracy of the geological framework at Sangiran, putting fossils from various layers at ages ranging from 1.8 million years to 1 million years ago.

Simple tools, long journeys

Whatever the resolution on the Java dates, the next oldest undisputed traces of early humans outside Africa are primitive stone tools at 'Ubeidiya, Israel, dated to as early as 1.5 million years ago. These tools represent an early stage of the relatively advanced Acheulean technology, which includes "handaxes" and other symmetrical tools carefully crafted according to a preconceived plan. Similar tools began to show up in Africa about 1.6 million years ago, and some researchers proposed that the invention of the tools spurred colonization out of Africa at that time.

But the Dmanisi results may shatter that theory. Not only are the Georgian fossils older than the earliest known Acheulean tools in Africa, but the Dmanisi people had only simple stone tools, as archaeologists Antje Justus of the Roman-German Central Museum and Medea Nioradze of the Georgia State Museum reported at Tautavel. The Dmanisi tools resemble the Oldowan tools found in East Africa's Olduvai Gorge as early as 1.8 million years ago—simple stone flakes, scrapers, and various "chopping tools." If the Dmanisi people managed to travel thousands of miles with these simple tools, "this means that the Oldowan adaptation was more complex than people thought," comments Milford Wolpoff, a paleoanthropologist at the University of Michigan, Ann Arbor. "The overwhelming discovery is that there are Oldowan-using people colonizing outside of Africa." Adds paleoanthropologist Susan Antón of the University of Florida, Gainesville, a co-author on the paper: "If we are right about when hominids left Africa, it is biology, not new tools, that prompted their dispersal. As soon as you get larger body sizes and brains, you see shifts in what they eat and how far they range that ultimately lead them out of Africa."



"As soon as *Homo erectus* evolves in Africa, they're out."
—Alan Walker

Indeed, back in 1989 Walker and biological anthropologist Pat Shipman of Pennsylvania State University, University Park, proposed that once australopithecines evolved into the genus *Homo* and became more carnivorous, they would have expanded their range, because carnivores need large territories. But in 1989, there was no sure evidence of such an early expansion. Now there is. "As soon as *Homo erectus* evolves in Africa, they're out," notes Walker, who prefers this species name to *H. ergaster*. Ian Tattersall, a paleoanthropologist at the American Museum of Natural History in New York City, agrees: "The story is looking strong that up until 1.9 million years ago the only hominids were archaic [types] restricted to the forest fringes [of Africa]. Somehow, a modern body was acquired, then all hell broke loose and this strutting biped ... was mobile enough to set out of the forest fringes and walk out of Africa."

Although the evidence from Dmanisi supports the idea that hominids got out of Africa fast and early—and that *H. ergaster* was the first traveler—exactly where they went next and how they eventually got to Europe remains a mystery. Leaving the contested Java and Longgupo sites aside, the oldest accepted dates for humans in Asia are roughly 1.1 million years for hominid fossils found at Gongwanling in China (see map), says de Lumley. At the meeting, Gabunia proposed that the Dmanisi people went east and eventually gave rise to Asian *H. erectus*. Several researchers at the meeting found that quite plausible, given the dates and features of the fossils, but others are skeptical. "No one knows who were the ancestors of Asian *H. erectus*," says Harvard's Bar-Yosef. "There was more than one wave out of Africa," and so there are many possibilities for *H. erectus*'s ancestors.

When it comes to Europe, the evidence is even more puzzling, for there is an almost 1-million-year gap between Dmanisi and any European site. And the much younger stone tools at European sites such as Gran Dolina at Atapuerca, dated to about 780,000 years ago, are still the simple Oldowan type, as are those at most sites in Asia. The Acheulean technology is rarely seen outside Africa until about 500,000 years ago, yet it's hard to fathom why Acheulean toolmakers would be less mobile than Oldowan toolmakers.

One explanation, championed by paleoanthropologist Nicholas Rolland of the University of British Columbia in Victoria and raised again at the Tautavel meeting by archaeologist Sarah Milliken of Oxford University, is the "long journey" hypothesis: that early humans first ventured out of Africa via the Middle East with Oldowan tools close to 2 million years ago, but were prevented by climate and geography from turning west. Instead they dispersed east, taking a southern route to China and even Java. Then they turned north and started west again across more central reaches of Asia and Europe. In this view, the Oldowan-like tools at Atapuerca and Ceprano may have been left by the descendants of these early wanderers.

Whether this scenario holds water will depend on future research. "We just don't have enough sites and enough evidence yet," says Oxford University archaeologist Derek Roe. He predicts that "within the next 5 years there will be more dramatic discoveries of the magnitude of Dmanisi." Swisher adds that researchers have just begun to mine Dmanisi's rich fossil beds. But whatever routes early humans took in their colonization of the globe, the evidence already in from Dmanisi makes it clear that they got an early start out of Africa, arriving in Georgia not long after their first African appearance. "Once emancipated from the forest," says Tattersall, "you find these guys moving very, very fast."

–MICHAEL BALTER AND ANN GIBBONS

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