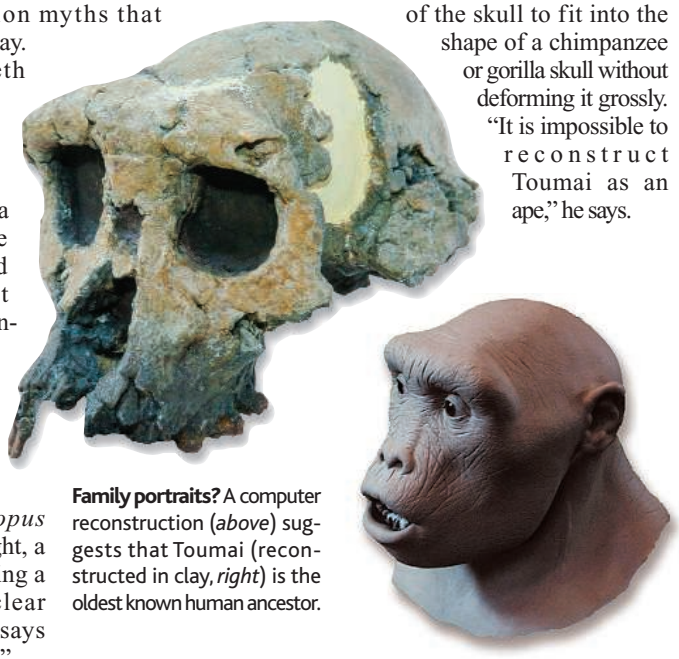
PALEOANTHROPOLOGY

Facelift Supports Skull's Status as Oldest Member of the Human Family

For paleoanthropologists seeking the roots of humanity, a striking skull discovered among the shifting sand dunes of the Djurab Desert of Chad in 2001 was a dramatic find, offering the first glimpse of a primate alive at the dawn of humankind. But although the nearly 7-million-year-old skull was introduced as that of the oldest known hominid, rivals soon argued that it looked more like a gorilla ancestor than a human (*Science*, 12 July 2002, p. 171). Now the skull of *Sahelanthropus tchadensis*, nicknamed Toumai, is back in headlines again. It appears in *Nature* this week with two new looks—a three-dimensional virtual reconstruction and a clay bust on the cover, a nod to creation myths that humans were made of clay.

Fresh fossils of teeth and jaw fragments plus a state-of-the-art analysis of the virtual skull show that Toumai is indeed a hominid, or a member of the lineage that includes humans and our ancestors but not other apes, argues paleontologist Michel Brunet of the University of Poitiers, France, leader of the team that discovered Toumai. The new analysis also suggests that *Sahelanthropus* might have walked upright, a traditional marker of being a hominid. "It is quite clear Toumai is a hominid," says Brunet. "It is not a gorilla."



Family portraits? A computer reconstruction (*above*) suggests that Toumai (reconstructed in clay, *right*) is the oldest known human ancestor.

CREDITS: M.P.F.T. (ARTIST'S RECONSTRUCTION); E. DAYNES)

Other researchers applaud the sophistication of the reconstruction, performed by a team led by neurobiologist Christoph Zollikofer of the University of Zurich (UZ), Switzerland. "What a facelift! This beautiful reconstruction is the outcome of high technology combined with a deep understanding of anatomy," says Tel Aviv University paleoanthropologist Yoel Rak. But some caution that although the new evidence helps build the case that Toumai was a hominid, its identity is far from certain. "I'd be happy to put it down as [a very early] hominid," says anatomist Fred Spoor of University College London. "But it's a time we know so little about that I am still skeptical."

Brunet took the skull to Zollikofer and UZ anthropologist Marcia Ponce de Leon, known for their sophisticated high-resolution computed tomography scans and analyses. The skull had been crushed under a sand dune and distorted, and the researchers were able to erase the ravages of time in the computer, using three-dimensional computer graphics tools to rebuild it piece by piece. The resulting face is taller, with a bit more snout than seen in the original.

Zollikofer and Ponce de Leon then identified 39 landmarks on the skull, which they used to compare it directly with the skulls of fossil hominids, two chimpanzee species, and gorillas. They found that the shape of Toumai's skull "falls exactly within the hominids," says Zollikofer. No matter how they tried, they could not force the pieces of the skull to fit into the shape of a chimpanzee or gorilla skull without deforming it grossly. "It is impossible to reconstruct Toumai as an ape," he says.

Several researchers find the virtual evidence compelling. "I was worried about the distortion, but they are great at building virtual reconstructions that test hypotheses about how these fossils looked," says anthropologist John Kappelman of the University of Texas, Austin.

The reconstruction also revealed new evidence that suggests *Sahelanthropus* walked upright. A virtual line from the top to the bottom of Toumai's eye orbit makes roughly a right angle with another virtual plane at the base of the skull. That right angle is also seen in humans, reflecting that the head sits directly atop a vertical spine when walking upright. The angle between the planes is much smaller in the quadrupedal apes studied, reflecting that the head sits in front of a more horizontal ▶

ScienceScope

Hubble Relief

Finally, some good news for the Hubble Space Telescope. NASA engineers say that they can run Hubble on two gyroscopes rather than the three now operating. Space agency managers hope that turning off one gyro could extend Hubble's life by 6 months or more without affecting the quality of science returned. That could mean more time to revisit Hubble—either by shuttle or by robot—for an overhaul. Science chief Al Diaz says he will decide soon whether to turn off a gyro; currently, no repair visit is on the books, and the telescope is expected to die in late 2007 or early 2008.

NASA also says there is good news on the robotic servicing front. Engineers told *Science* that they have a plan to install two sets of three gyroscopes within an instrument now waiting on Earth to be installed in Hubble. With new gyros and new batteries, they say, Hubble could continue to operate for well over a decade. But incoming Administrator Michael Griffin likely will revisit the servicing issue. Griffin's Senate confirmation hearing is slated for 12 April.

–ANDREW LAWLER

Bay State Passes Stem Cell Bill

Massachusetts legislators overwhelmingly passed measures last week that explicitly allow research cloning, or somatic cell nuclear transfer (SCNT). The action promises to "put the state firmly in support of SCNT and other embryonic stem cell research," says Kevin Casey, director of government relations at Harvard University.

The state House and Senate have yet to agree on specifics of the final measure, which also would outlaw reproductive cloning. Republican Governor Mitt Romney opposes research cloning, but the bills passed by well over the two-thirds majority needed to override his promised veto. Senate president Robert Travaglini (D) has indicated that another bill is in the works that would earmark as much as $100 million to fund the research.

Harvard stem cell researcher George Daley is thrilled about what he calls "a real victory for science." Efforts to inform legislators helped, says Daley, who demonstrated nuclear transfer to a state senator. "I think this made it quite clear to him that SCNT is not about cloning babies," he says.

–CONSTANCE HOLDEN

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neck, explains co-author Daniel Lieberman of Harvard University. Thus the team concludes that *Sahelanthropus* "might" have been bipedal. "I'm the first to say you need postcranial fossils to be 100% sure, but it's darned hard to think how Toumai could not have walked upright," says Lieberman.

However, others caution that skulls don't walk upright by themselves, and that lower limbs are needed to prove this hallmark trait. Until Brunet and his colleagues describe postcranial fossils, paleoanthropologist Milford Wolpoff of the University of Michigan, Ann Arbor, sees Toumai as an ape, citing what he calls apelike features in the base of the neck.

More fossils also are needed to settle the question of how *Sahelanthropus* is related to later hominids. "There is still insufficient fossil evidence to determine whether there were one, two, or more hominid species lineages between 5 [million] and 7 million years ago in Africa," says paleoanthropologist Tim White of the University of California, Berkeley.

Brunet declines to comment on reports that his team has also discovered a partial thighbone, but he adds cryptically: "Surely postcranials will be coming in the future. I will be very, very surprised if it is not bipedal." –ANN GIBBONS

PALEOCLIMATOLOGY

Cosmic Dust Supports a Snowball Earth

Answering questions about Earth's climate of more than half a billion years ago can be a challenge—even questions as stark as whether land and sea were completely coated by ice from pole to pole. Indeed, the revival of the Snowball Earth hypothesis almost 7 years ago has bogged down of late, as paleoclimatologists have failed to turn up unequivocal evidence that ice enrobed our planet.

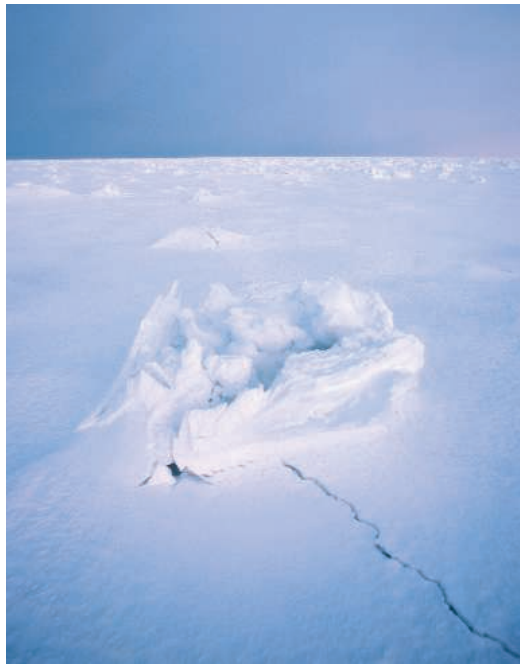
But on page 239 of this issue, a group of geochemists offers a new snowball marker: the element iridium, which continually rains down on us from space. They say they found so much iridium deposited at the end of a glaciation 635 million years ago that the planet must have been frozen pretty much solid for 12 million years straight. "I think this is a very exciting discovery," says geochemist Frank Kyte of the University of California, Los Angeles. Like any new tool, iridium needs some more work, but "I'm sure it will invoke a lot of discussion."

This isn't iridium's first appearance as a timekeeper. But geochemists Bernd Bodiselitsch and Christian Koeberl of the University of Vienna, Austria, and their colleagues took a new tack when they analyzed 44 elements including iridium along three cores drilled by copper miners in Zambia and the Democratic Republic of the Congo. Bodiselitsch and his colleagues figured that on an iced-over world, the iridium-rich meteoritic dust that rains onto Earth would accumulate until the snowball ended in a sudden meltdown, as climate modelers believe would happen. All the iridium accumulated in the ice would then be deposited in a single, thin layer of marine sediment. The more iridium deposited at the end of a snowball, the longer the snowball had gone on.

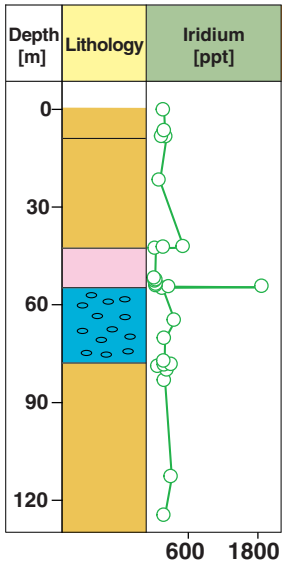
In the first few centimeters of sediment laid down on top of glacial sediments, Bodiselitsch and colleagues indeed found sharp spikes in the abundance of iridium. A spike showed up in all three cores at the end of the Marinoan glaciation about 635 million years ago and in two cores at the end of the earlier Sturtian glaciation about 710 million years ago. The iridium could conceivably have been homegrown—from a volcanic eruption or concentrated from crustal rock by some geochemical process—but several other elements were present in proportions typical of meteorites, not the crust. And the proportion of iridium to some other elements suggested that geochemical processing had not concentrated the iridium, they concluded. If meteoritic material was falling to Earth 635 million years ago at anything like the rate it has during the past 80 million years, the group calculates, the Marinoan glaciation lasted 12 million years, give or take 3 million years.

If the Marinoan ice age managed to save up 12 million years' worth of extraterrestrial iridium, it must have iced over the entire planet, researchers agree. The alternative to Snowball Earth has been Slushball Earth (*Science*, 26 May 2000, p. 1316). Rather than pole-to-pole ice, some paleoclimate modelers have suggested that Marinoan glaciation might have left tropical oceans ice-free and still produced glacial deposits near equatorial continents. But a slushball would have melted down within something like a million years as volcanoes belching carbon dioxide fueled a growing greenhouse. "It's hard to see what would keep a slushball around for 10 [million] or 20 million years," says climate modeler Raymond Pierrehumbert of the University of Chicago. And even if a slushball did last, its glaciers—unlike those of a snowball—would continually flow down to the sea, steadily depositing iridium, not producing a spike of it.

Geochemists are excited but naturally cautious. "Iridium is a strong indicator of extraterrestrial material," says Bernhard Peucker-Ehrenbrink of the Woods Hole Oceanographic Institution in Massachusetts. "However, it is just one of a series of useful tracers." He and others, he expects, will be pursuing other extraterrestrial tracers such as isotopes of helium and of osmium to test the claim of a Snowball Earth. Prompting such testing "is what good, interesting, provocative papers should do," he says. –RICHARD A. KERR



The ice was all around? A true Snowball Earth would have coated the globe with ice.



No accident. The discovery of a spike of cosmic iridium (green line) at the end of an ancient ice age (top of blue glacial sediments) suggests that ice covered the planet.

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