Research & Discovery

Portrait in DNA

Can forensic analysis yield police-style sketches of suspects? BY CHRISTINE SOARES

Male, short and stout, with dark skin, brown eyes, shovel-shaped teeth, type A+ blood and coarse, dark brown hair giving way to pattern baldness. He would have a high tolerance for alcohol and a higher-than-average risk of nicotine dependence—fortunately, he lived thousands of years before humans discovered smoking. The description of a Stone Age Greenland resident published in February paints an extraordinary portrait of a man who vanished more than 4,000 years ago, drawn almost solely from his DNA remains.

The analysis, led by Danish scientists, not only marks the first full sequencing of an ancient human genome but also offers a startling example of how much modern-day detectives can discern just from a suspect's genetic code. Far beyond using DNA "fingerprints" to link an individual to a crime scene, forensic profiling is edging toward the capability to create a police-artist-style sketch of an unknown person by reading traits inscribed in the genome. "The body interprets the DNA to determine the appearance of the face," says anthropologist Mark Shriver of Morehouse College, who hopes to duplicate that ability within a decade.

The scientists reconstructing the ancient Greenlander had only a few tufts of hair, preserved in permafrost, from which they extracted DNA. The hair itself is dark and thick and contains chemical traces indicating mainly a seafood diet. From the man's genes, the researchers resolved a long-standing debate about the origins of Greenland's paleo-Eskimos by showing he had a pattern of DNA variations most common in Siberian population groups. Having established his ancestral origins in northern Asia, the team could then interpret variations called single-nucleotide polymorphisms (SNPs) in four genes linked to brown eye color in modern Asians. The same method revealed SNPs associated with shovel-shaped front teeth and a dry type of earwax, both traits common in modern Asians and Native Americans. Four more SNPs suggest that he probably had dark skin. Another set of variations typical of populations adapted to cold climates indicates he had a compact body and ample body fat.

Together those traits might not make the ancient Greenlander stand out in a lineup, but they could dramatically narrow the search for suspects. A handful of high-profile criminal cases has already demonstrated the utility of even basic prospective information. In 2007 Christopher Phillips and his colleagues at the University of Santiago de Compostela in Spain used markers in a DNA sample obtained from a toothbrush to identify a suspect in the 2004 Madrid train bombing as being of North African descent. Police later confirmed that the terrorist was Algerian.

DNA PROFILING could take on new meaning as scientists discover how genes produce a specific trait. Such advances could allow law enforcement to sketch a description from clues in a suspect's genes.

PETER DAZELEY *Getty Images*

In an infamous Louisiana serial killer investigation, witness testimony had indicated a Caucasian culprit, but DNA evidence pointed to someone of significant African-American and Native American descent. Police widened their search and eventually caught the killer.

Having more to go on than ancestry, a generally poor indicator of appearance, is the goal of programs such as the DNA Initiative of the National Institute of Justice, which funds research into alternative genetic markers for forensic use. Daniele Podini of George Washington University is developing a forensic kit to determine, by analyzing 50 to 100 genetic markers, a suspect's eye and hair color, sex and probable ancestry. "The idea is just to provide another investigational tool," he says, "one that can help corroborate the testimony of a witness or reduce the number of suspects."

Getting more specific gets significantly more difficult, Podini adds. DNA alone offers few clues to age, for instance. With whole cells, researchers could examine telomeres, the chromosomal end caps that wear away with time, but individual health and other factors can influence their shrinkage. One recent study showed that dedicated athletes in their 50s might have the telomeres of a 25-year-old. Another important feature in profiling, height, has hereditary roots but also depends on environmental factors, such as nutrition during childhood.

Nevertheless, pinning down the effects of genes that influence body development is the key to predicting a specific individual's looks. Shriver is studying populations in Europe and mixed-race groups elsewhere in the hope that correlating a Gallic nose or smiling Irish eyes with genes that influence their distinctive shapes may begin to crack the code the body uses to build a specific feature. He is even exposing inch-square patches of volunteers' skin to ultraviolet light to gauge the range of skin shades and tones possible for people with various racial and ethnic backgrounds.

Skin-deep is as far as a DNA sketch should go, according to some bioethicists. The ancient Greenlander also had an elevated risk for hypertension and diabetes. A modern all-points bulletin could, in principle, describe a suspect's pigmentation, ancestry, and higher-than-average likelihood of being obese, a smoker, alcoholic or just depressed. "I think there are some valid ethical issues around this kind of work," Shriver remarks.

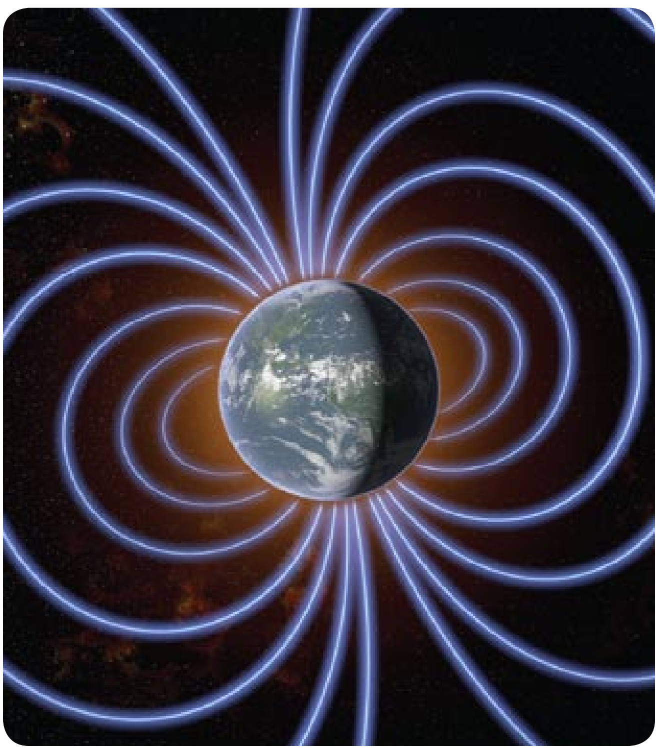
Practical considerations may be what delays deployment of any but the simplest forensic kits, though. "The forensic field is very, very conservative," Podini says, "so before you actually apply something to casework, it has to be proven beyond a reasonable doubt as something that works well, is reliable and is accepted by the scientific community."

RECONSTRUCTED: Ancient DNA provided details about the looks of a man who lived in Greenland more than 4,000 years ago.

Shields Up

Magnetized rock sets start of magnetic field closer to life's origin BY JOHN MATSON

EARTH'S ROBUST MAGNETIC FIELD PROTECTS THE PLANET AND its inhabitants from the full brunt of the solar wind, a torrent of charged particles that on less shielded planets such as Venus and Mars has over the ages stripped away water reserves and degraded their atmospheres. Unraveling the timeline for the emergence of that magnetic field and the mechanism that generates it—a dynamo of convective fluid in Earth's outer core—can help constrain the early history of the planet, including the interplay of geologic, atmospheric and astronomical processes that rendered the world habitable.



LINES OF DEFENSE: New evidence suggests that Earth's magnetic field, which protects the planet from the full force of the solar wind, got going about 3.45 billion years ago, about when life began.

FROM "ANCIENT HUMAN GENOME SEQUENCE OF AN EXTINCT PALAEO-ESKIMO," BY MORTEN RASMUSSEN ET AL., IN *NATURE*, VOL. 463; FEBRUARY 11, 2010 (*man*); PHOTO RESEARCHERS, INC. (*Earth's magnetic field*)

University of Rochester geophysicist John A. Tarduno and his colleagues have attempted to do just that, presenting evidence that Earth had a dynamo-generated magnetic field as early as 3.45 billion years ago, just a billion or so years after the planet had formed. The new research, in the March 5 *Science*, pushes back the record of Earth's magnetic field by at least 200 million years; a related group had presented similar evidence from slightly younger rocks in 2007, arguing for a strong terrestrial magnetic field 3.2 billion years ago.

Tarduno and his team analyzed rocks from the Kaapvaal craton, a region near the southern tip of Africa that hosts relatively pristine early Archean crust. (The Archean eon began about 3.8 billion years ago and ended 2.5 billion years ago.) In 2009 they had found that some of the rocks were magnetized 3.45 billion years ago—roughly coinciding with the direct evidence for Earth's first life, at 3.5 billion years ago. But an external source for the magnetism—such as a blast from the solar wind—could not be ruled out. Venus, for instance, which lacks a strong internal magnetic field, does have a feeble external field induced by the impact of the solar wind into the planet's dense atmosphere.

The new study examines the magnetic field strength required to imprint magnetism on the Kaapvaal rocks; it concludes that the field was 50 to 70 percent of its present strength. That value is many times greater than would be expected for an external magnetic field, such as the weak Venusian field, supporting the presence of an inner-Earth dynamo at that time.

The researchers then extrapolated how well that field could keep the solar wind at bay and found that the early Archean magnetopause, the boundary in space where the magnetic field meets