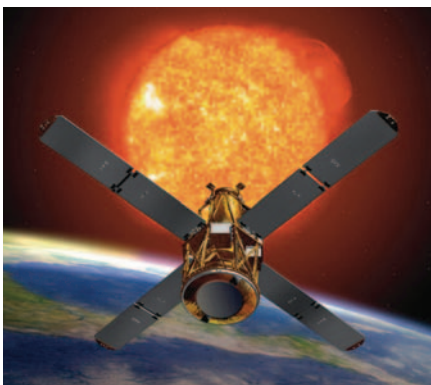


he notes. He and his coworkers describe their findings in the Feb. 18 *Science*.

Scientists don't fully understand the origins of TGFs, but flashes seem to be associated with lightning. The multimillion-volt electric fields generated between strong thunderstorms and higher layers of the atmosphere probably propel stray electrons upward at nearly the speed of light, says Umran Inan, a physicist at Stanford University. When one such electron smashes into an atom in the atmosphere, it can knock loose several other electrons, starting a chain reaction that slows only when the cascade of electrons reaches altitudes where atoms are few and far between.

According to some models of the phenomenon, most of a TGF's gamma rays spew upward in a beam no more than



**STARING AT THE SUN** A satellite designed to observe solar flares also detects high-energy photons produced by exotic phenomena in Earth's atmosphere. Artist's depiction shows the satellite orbiting Earth.

100 kilometers wide. Smith and his colleagues estimate that if that's the case, given the satellite's detection rate, TGFs may occur high in Earth's atmosphere at least 5,000 times each day. —S. PERKINS

## In the Buff

### Stone Age tools may have derived luster from diamond

**Ancient Chinese people may have used diamonds to polish their stone axes to mirrorlike finishes, according to a new analysis. Other than pushing back by several thousand years the date for the first known use of diamonds, the findings also suggest**

that Neolithic Chinese societies were more technologically advanced than previous studies had shown.

Some sections of the ax surfaces are almost as smooth as some silicon wafers used to make computer chips, says Peter Lu, a physicist at Harvard University. "Somehow, Stone Age people . . . were able to make something smooth enough that you could pattern a circuit on it," he says. In an attempt to discover how the polishing was done, Lu obtained four ceremonial burial axes from the tombs of two Neolithic Chinese societies—the Liangzhu culture and the Sanxingcun culture—that once inhabited parts of southern China near what is now Shanghai.

The stone axes had been dated by others to between 4000 and 2500 B.C.

To determine what kind of stone the axes were made of, Lu used X-ray diffraction, scanning electron microscopy, and electron microprobe analysis. These techniques enabled him to determine the axes' chemical composition as well as the crystal structure of the stones' minerals. He found that all four axes were composed primarily of three minerals, the most abundant one being the aluminum oxide called corundum, which is the stuff of rubies and sapphires. Corundum's presence was a surprise, says Lu.

It's the second-hardest mineral on Earth; only diamond is harder. Lu reasoned therefore that the only mineral strong enough to polish a corundum-rich ax would have been diamond. "Everyone thought the ancient Chinese were using quartz" for their polishing, he says. Quartz, however, is too soft to buff corundum into a shine.

To test his theory, Lu conducted a series of polishing experiments on one of the burial axes. Using a diamond saw, he sliced the ax parallel to the polished surface and then buffed the new surfaces with commercial polishing equipment using three abrasives: diamond, corundum, and quartz.

Lu quantified the smoothness achieved with each abrasive by using an atomic force microscope to measure nanoscale features on all the samples' surfaces. Only the diamond-polished sample closely matched the smoothness of the ancient surface, he reports in the February *Archaeometry*.

There are two known diamond deposits

within 300 kilometers of the burial sites, a distance that could have been traversed by Neolithic people, Lu notes.

"Lu and his colleagues are the first to seriously address the question of what abrasives were used [in Neolithic China]," says Janet Douglas, a conservation scientist at the Smithsonian Institution in Washington, D.C. The new work also indicates that ancient Chinese artisans could have used diamond to work jade into thousands of smooth, gleaming objects, she says.

Lu also wonders whether Neolithic societies polished jade with diamond, since it would have been a more efficient abrasive than quartz. —A. GOHO



**TOOL TALES** This 4,500-year-old ax from the Neolithic Liangzhu culture of ancient China may have been polished with diamond.

## Spying Saturn's Light Show

### Anomalous aurora dazzles scientists

**Among the solar system's auroras, the dancing lights that paint Saturn's skies show a distinct style.**

Three reports in the Feb. 17 *Nature* describe a choreographed experiment conducted 13 months ago, in which the Earth-orbiting Hubble Space Telescope and the Cassini spacecraft, then en route to Saturn, both examined Saturn's south pole. Hubble took ultraviolet pictures of Saturn's auroras while Cassini recorded radio emissions from the same regions of the planet. Cassini also measured the solar wind, the flow of charged particles from the sun.

The measurements provide the most accurate glimpses yet of Saturn's auroras, says John Clarke of Boston University, a coauthor on all three studies.

Auroras, such as Earth's northern lights, arise when charged particles from space strike a planet's magnetosphere, the bubble-shaped region defined by a planet's magnetic field. Particles streaming into the upper atmosphere collide with atoms and molecules there and produce flashes of radiation ranging from ultraviolet to radio wavelengths.

Scientists have made detailed observations of auroras only on Earth, Jupiter, and now Saturn. Earth's auroras are driven by charged particles from the solar wind. The particles driving Jupiter's auroras come

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