SPACE TRAVEL

Back to the Moon?

PROBES MAY GO, BUT ASTRONAUTS WILL HAVE TO WAIT **BY MARK ALPERT**

Scientists who study Earth's moon have two big regrets about the six Apollo missions that landed a dozen astronauts on the lunar surface between 1969 and 1972. The biggest regret, of course, is that the missions ended so abruptly, with so much of the moon still unexplored. But researchers also lament that the great triumph of Apollo led to a popular misconception: because astronauts have visited the moon, there is no compelling reason to go back.

In the 1990s, however, two probes that orbited the moon—Clementine and Lunar Prospector—raised new questions about Earth's airless satellite. One stunning discovery was strong evidence of water ice in the perpetually shadowed areas near the moon's poles. Because scientists believe that comets deposited water and organic compounds on both Earth and its moon, well-preserved ice at the lunar poles could yield clues to the origins of life. Just as important, though, was the detection of an immense basin stretching 2,500 kilometers across the moon's far side. Carved out by an asteroid or comet collision, the South Pole–Aitken Basin is a 13-kilometer-deep gouge into the lunar crust that may expose the moon's mantle. It is the largest impact crater in the entire solar system.

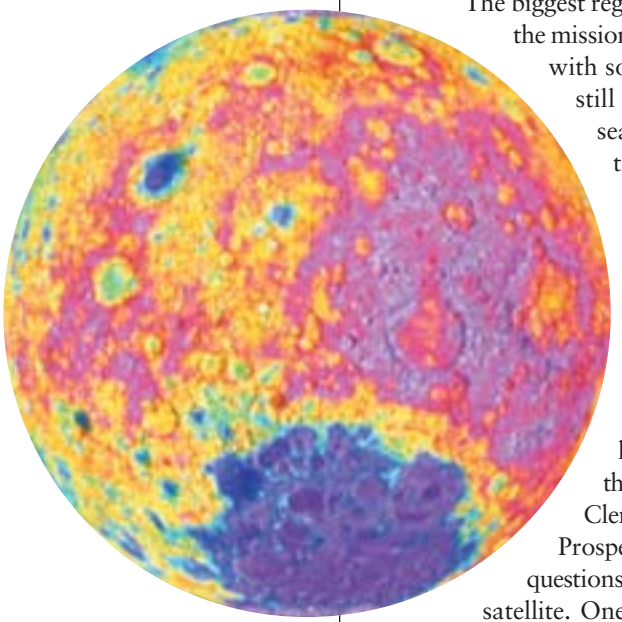
Thanks to rock samples collected by Apollo astronauts, lunar geologists know that impact basins on the moon's near side were created about 3.9 billion years ago. South Pole–Aitken is believed to be the moon's oldest basin, so determining its age is crucial. If it turns out to be not much older than the near-side basins, it would bolster the "lunar cataclysm" theory, which posits that Earth and its moon endured a relatively brief but intense bombardment about half a billion years *after* the creation of the solar system. Planetary scientists are at a loss to explain how such a deluge could have occurred.

These discoveries have put the moon back on the exploration agenda, but some scientists are unenthusiastic about the lunar missions that have been scheduled so far. The European Space Agency expects to launch a lunar orbiter called SMART-1 in March, but the craft's primary goal is to test an ion engine similar to the one already tested in NASA's Deep Space 1 mission. Lunar-A, a Japanese probe to be launched this summer, is designed to implant seismometers on the moon by hurling missile-shaped penetrators into the surface, but technical difficulties have limited the craft to only two penetrators, so the risk of failure is high. The Japanese space agency is planning a more ambitious mission named SELENE for 2005, but this lunar orbiter will not be able to answer the fundamental questions posed by the Clementine and Lunar Prospector findings. Says Alan Binder, the principal investigator for Lunar Prospector: "We need to get to the surface, dig it up and see what's there."

An upcoming series of NASA missions, called New Frontiers, will most likely include an unmanned lunar lander that could scoop up about one kilogram of rock fragments from the South Pole–Aitken Basin and then rocket the samples back to Earth for detailed analysis. Michael B. Duke, a Colorado School of Mines geologist who proposed a similar mission in 2000, says the selection of the landing site is critical. Ideally, the site would have impact melt rocks revealing both the age of the basin and the composition of the lunar mantle and would also be close enough to the South Pole so that researchers could test for the presence of ice. To minimize risk, the best solution would be to send landers to more than one site, but that might break the mission's budget, which will probably not exceed $650 million.

The notion of sending astronauts back to the moon seems even more far-fetched given NASA's money troubles. But the agency offered a glimmer of hope last October when Gary L. Martin, NASA's first "space architect," sketched out a possible next step for

FAR SIDE topographic map of the moon shows the immense South Pole–Aitken Basin (*bottom*).



COURTESY OF THE LUNAR AND PLANETARY INSTITUTE

MOON PIE IN THE SKY

A few years ago, when space entrepreneurship was all the rage, several companies promised to launch privately funded probes that would explore the moon and make a profit, too. But so far the moon business has remained earthbound. One example: LunaCorp in Fairfax, Va., had intended to finance an ice-hunting mission on the lunar surface by selling television and Internet rights to commercial sponsors. Now the company is focused on a more modest plan—putting a camera-carrying satellite into orbit around the moon—but the effort hinges on persuading NASA to buy the satellite's maps of the lunar surface. David Gump, LunaCorp's president, admits that commercial interest alone is not strong enough to cover the mission's projected $20-million cost.

human exploration: positioning a small space station at the L1 Earth-moon Lagrangian point, where the gravitational pulls of Earth and its moon cancel each other out. Located only 65,000 kilometers from the moon—one sixth the distance between the moon and Earth—this point would provide easy access to the lunar surface (and to Mars as well). But with NASA still struggling to assemble the International Space Station in low-Earth orbit, nobody is expecting to see a replay of Apollo anytime soon.

BIOTECH

Fixing Food

ALLERGEN-FREE COMESTIBLES MIGHT BE ON THE WAY **BY CAROL EZZELL**

A bite of a cookie containing peanuts could cause the airway to constrict fatally. Sharing a toy with another child who had earlier eaten a peanut butter and jelly sandwich could raise a case of hives. A peanut butter cup dropped in a Halloween bag could contaminate the rest of the treats, posing an unknown risk.

These are the scenarios that "make your bone marrow turn cold," according to L. Val Giddings, vice president for food and agriculture of the Biotechnology Industry Organization. Besides representing the policy interests of food biotech companies in Washington, D.C., Giddings is the father of a four-year-old boy with a severe peanut allergy. Peanuts are among the most allergenic foods; estimates of the number of people who experience a reaction to the legumes hover around 2 percent of the population.

Giddings says that peanuts are only one of several foods that biotechnologists are altering genetically in an attempt to eliminate the proteins that wreak havoc with some people's immune systems. Although soy allergies do not usually cause life-threatening reactions, the scientists are also targeting soybeans, which can be found in two thirds of all manufactured food, making the supermarket a minefield for people allergic to soy. Biotechnologists are zeroing in on wheat, too, and might soon expand their research to the rest of the "big eight" allergy-inducing foods: tree nuts, milk, eggs, shellfish and fish.

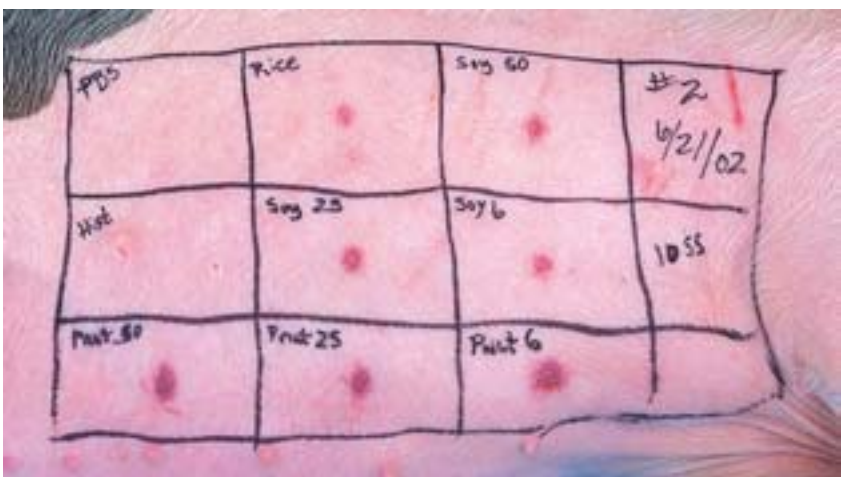
Last September, for example, Anthony J. Kinney, a crop genetics researcher at DuPont Experimental Station in Wilmington, Del., and his colleagues reported using a technique called RNA interference (RNAi) to silence the genes that encode p34, a protein responsible for causing 65 percent of all soybean allergies. RNAi exploits the mechanism that cells use to protect themselves against foreign genetic material; it causes a cell to destroy RNA transcribed from a given gene, effectively turning off the gene.

Whether the public will accept food genetically modified to be low-allergen is still unknown. Courtney Chabot Dreyer, a spokesperson for Pioneer Hi-Bred International, a subsidiary of DuPont, says that the company will conduct studies to determine whether a niche market exists for low-allergen soy before developing the seeds for sale to farmers. She estimates that Pioneer Hi-Bred is seven years away from commercializing the altered soybeans.

Doug Gurian-Sherman, scientific director of the biotechnology project at the Center for Science in the Public Interest—a group that has advocated enhanced Food and Drug Administration oversight for genetically modified

COUNTERING INTOLERANCE

Although relatively few people have outright food allergies—in which the body raises an immune attack against proteins within a food—many more have difficulty digesting some foods. Dairy products are already on the market for those who develop gas, bloating and diarrhea from drinking milk or eating ice cream. A similar product could soon emerge for those allergic to, or intolerant of, wheat gluten. Scientists led by Chaitan Khosla of Stanford University have found an enzyme that when orally administered might allow people with celiac sprue, an allergy to gluten, to eat some wheat products. It could also help buffer the effect of less severe gluten intolerance.



PORCINE PREDICTOR: Various proteins from foods such as soybeans are injected underneath the skin of pigs to help identify those items that are most allergenic.

AGRICULTURAL RESEARCH SERVICE, USDA; SCOTT BAUER