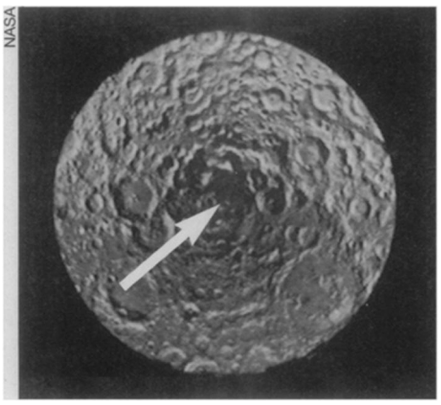
Craft finds evidence of ice on the moon

A spacecraft has gathered the best evidence yet that ice lies deep within craters at the moon's north and south poles. Data from NASA's Lunar Prospector, launched 2 months ago, suggest that the sunless craters contain frozen water—perhaps 300 million metric tons.

That doesn't mean Tara Lipinski should grab her skates and head for the moon. The ice is probably in the form of frost mixed with lunar soil. By weight, it makes up only about 1 percent of the floor material of lunar craters that lie in permanent shadow, William Feldman of the Los Alamos (N.M.) National Laboratory reported last week at a press briefing at NASA's Ames Research Center in Mountain View, Calif.

He and team leader Alan Binder of the Lunar Research Institute in Gilroy, Calif., deduced the presence of water from data gathered by Prospector's neutron spectrometer. Cosmic rays hitting the moon generate energetic neutrons, which rattle around the lunar surface before escaping into space. These neutrons lose only a little energy when they bounce off heavy nuclei in the soil, but they give up much more in collisions with hydrogen nuclei, whose masses are close to that of the neutrons.

The spectrometer recorded a dip in the number of energetic neutrons as Prospector passed over the poles, indicating that these regions are slightly enriched in hydrogen. The hydrogen is almost certainly tied up in water, the Prospector team asserts. Feldman notes that the poles are not chilly enough to freeze two other hydrogen-rich gases—ammonia and methane—that are likely to be present. Although water is abundant in the cosmos, he admits that inferring its presence on the moon "is a leap of faith."

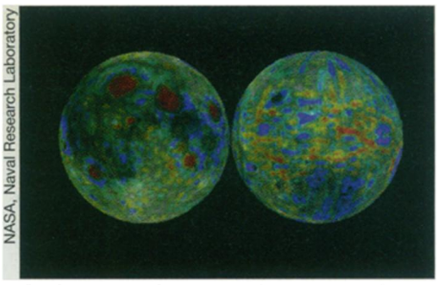


The moon's south pole, imaged by Clementine, shows a crater (arrow) that may contain ice.

That's a leap many planetary scientists are willing to make. In 1994, the Clementine craft bounced radio waves off the moon and found tentative evidence of frozen water inside polar craters (SN: 6/11/94, p. 383). "I find the Prospector results convincing and fascinating," says Clementine researcher Paul D. Spudis of the Lunar and Planetary Institute in Houston.

Binder touts the finding as a boon for space travelers. "For the first time, when we go to a planetary body . . . you can fuel up." Other researchers argue that gaining access to the ice, whether for hydrogen fuel or drinking water, might be more trouble than it's worth. "Digging out that ice is going to be cold, dark, and difficult work," notes Steven W. Squyres of Cornell University.

Researchers believe that the moon was hot and dry when it formed, but over billions of years it acquired water from comets pelting it. Because the sun makes a shallow angle at the moon's poles, the bottoms of craters there never see sunlight and are an ideal place to trap frozen water, Binder says. The amount of ice may indicate the frequency of comet hits and how long the poles have been in their present orientation.



In these new lunar gravity maps, red indicates the highest density, blue indicates the lowest.

Also at the briefing, Alex Konopliv of NASA's Jet Propulsion Laboratory in Pasadena, Calif., unveiled a new gravity map. It provides a peek beneath the lunar surface and makes possible more accurate estimates of the fuel required to orbit the moon. —*R. Cowen*

Cosmic rays sow the seeds of cloud growth

The lowly raindrop that splatters on the ground may have an origin far loftier than the clouds. According to a new atmospheric theory, cosmic rays streaming in from distant reaches of our galaxy help form one of the necessary ingredients of cloud droplets.

Cosmic rays crash through the lower layers of the atmosphere like tiny tractor-trailers with broken brakes. Moving at close to the speed of light, these nuclear fragments smash into air molecules hard enough to knock electrons loose. This well-documented process creates negatively and positively charged ions.

Atmospheric researchers have often ignored the role of such ions because they are relatively rare. The new theory, however, suggests that ions play a central role in creating aerosols—the minute but important airborne particles that can serve as the cores of growing cloud droplets.

Richard P. Turco of the University of California, Los Angeles and his colleagues present this idea in the March 1 GEOPHYSICAL RESEARCH LETTERS.

"If this mechanism works, and I think it does, it would be a major source of aerosols in Earth's atmosphere," says Turco.

Many aerosols are liquid droplets containing dissolved sea salt, sulfuric acid, organic molecules from trees, and other compounds. Over the continents, dust and soot are also aerosols. Both liquid and solid specks help clouds develop by encouraging the condensation of water vapor, which does not occur readily without an original seed particle of some sort in the air.

Despite the importance of aerosols, scientists remain uncertain about how they develop.

Turco and his coworkers suggest that ions created by cosmic rays form the nucleus of many aerosol particles. In this process, water with an extra proton and other positive ions combine with neutral molecules to make small clusters. Similar clusters grow around negative ions, such as a derivative of sulfuric acid. Soon, the negative and positive clusters clump to form a larger particle stable enough to persist as an aerosol.

The standard theory of aerosol formation holds that clusters form through neutral molecules coming together. In contrast, Turco's group argues that in many cases, the ion idea more accurately reflects aerosols observed in nature and in the laboratory.

Ion clusters grow in a wide range of conditions, whereas neutral molecules won't form clusters until the right circumstances arise, at which time a burst of aerosols develops. The researchers cite measurements showing that aerosols do not typically form in great bursts.

David S. Covert, an atmospheric chemist at the University of Washington in Seattle, says that the ion mechanism may play an important role in aerosol formation. "I'm sure it's significant, but I can't say whether it's the dominant process."

Covert notes that other research groups have also proposed new mechanisms for aerosol formation. The outstanding questions hamper climate predictions because aerosols help set Earth's temperature by absorbing and reflecting radiation. To judge the merits of these competing aerosol ideas, scientists must both repair to their labs and take to the skies. —*R. Monastersky*