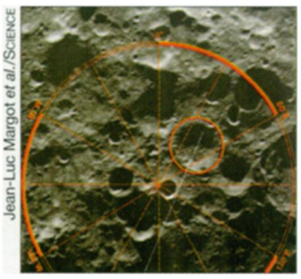
Astronomy

Watery prospects: Shoot the moon

Some spacecraft end their missions by sailing quietly into oblivion, but the impending demise of Lunar Prospector could make quite a splash.

Observations by the craft, which has orbited the moon since January 1998 and is running low on fuel, have indicated that several craters at the lunar north and south poles contain frozen water. Prospector's final moments—set for a few minutes before 6 a.m. EDT on July 31—may provide the best proof yet that water really exists on the moon. If astronauts can easily extract it from the lunar soil, water will be a valuable resource and could spur efforts to colonize the moon.



Jean-Luc Margot et al./Science

Radar image of the moon's south pole shows crater (small circle) that Lunar Prospector is set to crash into on July 31.

If all goes according to plan, the tiny craft will crash into Mawson crater, a 60-kilometer-wide dent at the moon's south pole. Because the crater's rim is high enough to prevent sunlight from ever illuminating the bottom, Mawson is an ideal place to harbor frozen water. An abundance of hydrogen atoms in Mawson, previously revealed by Prospector, also indicates the presence of water (SN: 10/10/98, p. 239).

Hurtling into the crater at 1.3 km per second, Prospector may shoot up a plume of water vapor—if Mawson contains as much ice as astronomers hope. Previous estimates suggest that the concentration of frozen water in Mawson could be as much as 2 percent and that the impact could heat as much as 18 kilograms of ice to a temperature of 400 kelvins.

The densest part of the water plume could remain aloft for 16 minutes, calculates David B. Goldstein of the University of Texas at Austin. Goldstein and his colleagues, who proposed sending Prospector to a watery grave, describe their analysis in the June 15 Geophysical Research Letters.

Of all the observatories that will cast their eyes on the moon this July 31, the Submillimeter Wave Astronomy Satellite has the best chance of detecting a water plume, says Goldstein. That's because its detectors are tuned to a wavelength at which water absorbs light. The Earth-orbiting craft, however, won't have a clear view of the moon until a half hour after the crash.

Even if the Submillimeter satellite misses the plume, that won't put a damper on the observations. Sunlight striking the rising column of water vapor will separate it into hydroxyl (OH) molecules and hydrogen, and these constituents should linger in the tenuous lunar atmosphere for several hours. Instruments joining the lunar-gazing party include the Hubble Space Telescope and the McDonald Observatory, near Fort Davis, Texas.

"A positive spectral detection of water vapor or its photodisassociated byproduct, OH, would provide definite proof of the presence of water ice," says Goldstein.

Both Goldstein and Alan B. Binder of the Lunar Research Institute in Gilroy, Calif., the chief scientist for Lunar Prospector, note that a failure to detect water would not rule out water's existence on the moon. For instance, Prospector could miss its intended target. Plowing into the lunar surface at a glancing angle of 6.5°, the craft might hit the crater's rim rather than its floor.

In addition, Mawson may not contain sufficient water to generate a detectable signal, or the models researchers have developed could be wrong. Binder and his colleagues put the overall probability of detecting a water signal at 10 percent.

Nonetheless, Prospector's controlled crash on July 31 "is a lot better than just running out of gas," comments James W. Head of Brown University in Providence, R.I. —*R.C.*

Biology

Dyeing to find muscle stem cells

While the strategy of transplanting muscle cells into people with muscular dystrophies or other muscle diseases makes sense in theory, it has not lived up to its promise. Few transplanted muscle cells survive and form new muscle fibers, notes Louis M. Kunkel of Children's Hospital in Boston. The problem appears to be that most transplanted cells are too set in their ways to regenerate muscle tissues. What's needed, says Kunkel, are muscle stem cells—less specialized cells whose sole purpose is to create new muscle.

At last month's American Society of Gene Therapy meeting in Washington, D.C., Kunkel's coworker Emanuela Gussoni reported progress in finding such stem cells. She, Kunkel, and their colleagues treated muscle tissue with a dye and found a population of cells that took up less of the dye than others did. The researchers borrowed the strategy from Richard Mulligan, also at Children's Hospital, who had accidentally found that a similar difference in dye uptake helps identify blood-forming stem cells in bone marrow.

Hoping that their dye-resistant subpopulation of cells was rich in muscle stem cells, Gussoni and her team injected the cells into female mice having a genetic condition similar to a muscular dystrophy. To prevent rejection of the foreign cells, the researchers irradiated the rodents to destroy their immune systems.

Since the transplanted cells came from male mice, the researchers followed the cells' survival and proliferation by looking for Y chromosomes. After 3 months, around 5 percent of the female rodents' muscle tissue contained cells with a Y chromosome, says Kunkel. The new cells were also making dystrophin, a crucial muscle protein that mice with the dystrophy-like condition are unable to make.

Curiously, bone marrow and spleen tissue also harbored cells with a Y chromosome, indicating that the transplanted cells gave rise to more than muscle. The cellular conversion may go both ways. A report last year showed that bone marrow cells can generate new muscle in addition to blood cells (SN: 3/7/98, p. 150).

Kunkel's team is now trying to determine how muscle stem cells injected into the bloodstream find their way to muscle tissue. For example, the scientists are examining whether exercise that breaks down muscle tissue stimulates the release of a signal that draws stem cells to the area. —*J.T.*

A surprising tale of a frog's tail

The tadpole's metamorphosis into a frog has intrigued biologists for more than a century. Scientists have long known that a hormone produced by the thyroid gland sets the dramatic event into motion, but they've had less insight into the influences of other molecules. Donald D. Brown of the Carnegie Institution of Washington in Baltimore and his colleagues have begun to address that issue.

The researchers have focused on the way that the tail of a tadpole disappears, or is resorbed, during metamorphosis. More than a dozen genes increase their activity during the tail resorption, said Brown last month in Charlottesville, Va., at the annual meeting of the Society for Developmental Biology.

Brown's group has also genetically altered frogs to overproduce certain hormones thought to act during metamorphosis. These hormones haven't proven as important as expected. Frogs engineered to make lots of growth hormone, for instance, become so fat that they die within 9 months after hatching, but they still undergo seemingly normal metamorphosis. Tadpoles that overproduce the hormone prolactin also metamorphose as usual—with one interesting exception.

"They do everything perfectly well, except they can't resorb their tails. They turn into frogs with extremely long tails," says Brown. The leftover tails lose all their muscles during metamorphosis, so they are like scar tissue, he adds. —*J.T.*