National Aeronautics and Space Administration

THE STAR WITNESS

A PUBLICATION OF NASA'S "AMAZING SPACE" EDUCATION PROGRAM

Special Feature

Hubble: A Lunar Prospecting Machine

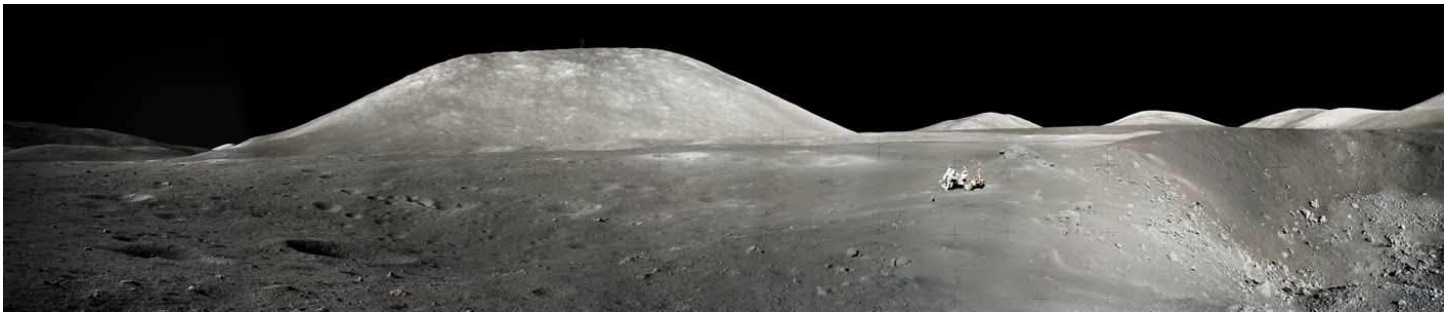


IMAGE: Apollo 17 Lunar Surface Journal and J. Garvin; from an image series composited by Zoltan Levay

By NASA's Amazing Space reporters
October 2005

Consider living on the Moon …
This is the sweeping view seen by the Apollo 17 crew in December, 1972. Their lunar rover is seen at center, right. Astronauts from six Apollo missions visited the Moon from 1969 to 1972. Each time they made the three-day, 250,000-mile journey, they brought enough air supply and food to last through their brief visits.

Eventually, human visitors to the Moon will stay for awhile, setting up an outpost. Future Moon pioneers cannot expect a spacecraft from Earth to deliver supplies every week, or even every month. They will need to live off the Moon's resources.

AMERICA HAS ALWAYS been a land of pioneers. Europeans settled in this country more than 300 years ago to build new homes and new lives. In the mid-1800s, about 250,000 Americans answered the call to move west.

They packed a few possessions in wagons and traveled thousands of miles across the country. Like their ancestors who settled this country, the pioneers used the resources they found around their new homes to build houses, plant crops, and search for water.

Now, 150 years later, the U.S. is considering another pioneering journey, this time to the Moon and beyond. Future residents of the Moon, however, will find it even harder to be pioneers. The Moon does not provide the most essential resource needed for life — an oxygen-rich atmosphere. Like the pioneers who settled the American west, astronauts will have to rely on their new surroundings to supply needed resources — in this case, oxygen.

Scientists know how to make oxygen gas from certain minerals, such as titanium oxides. They also know these minerals can be found on the Moon because they are present in some of the

Continued, page 2…

Continued from page 1…

rocks and soils that Apollo astronauts brought back to Earth in the 1970s. The question NASA scientists are trying to answer is: Are there other sites on the Moon that also contain these minerals?

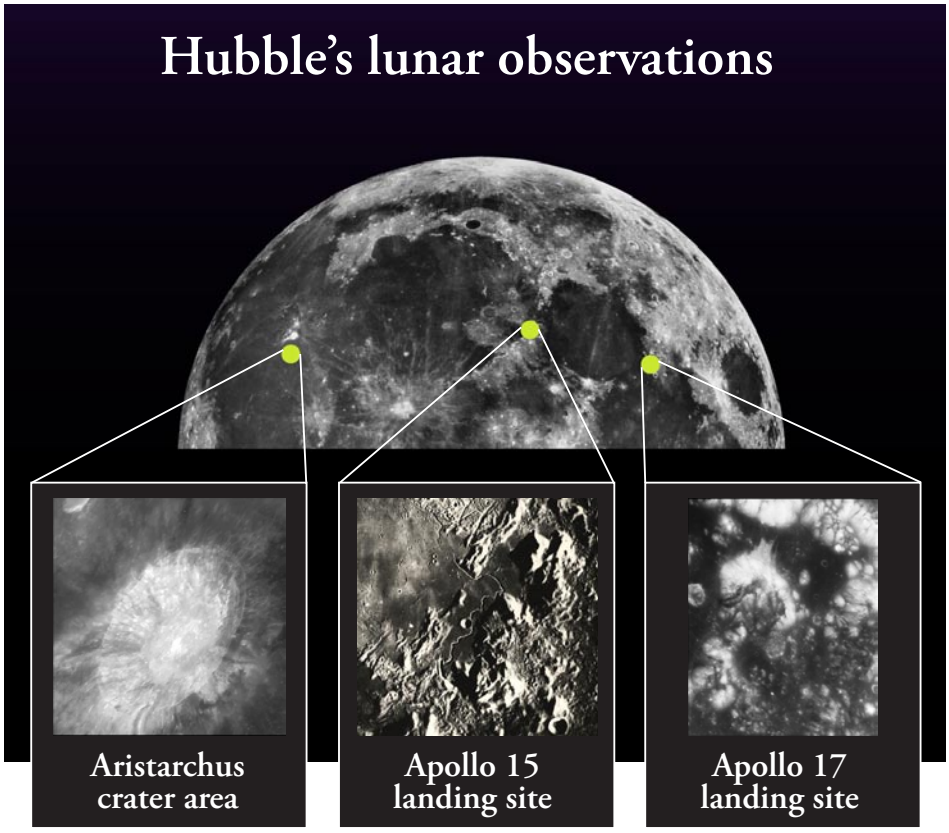
Hubble's hunt for resources

NASA used the Hubble Space Telescope to answer this question. The telescope looked at ultraviolet light reflected off the Moon's surface. Ultraviolet light reflected off titanium oxide minerals looks different from that of other minerals.

Hubble viewed the ultraviolet glow from minerals at two Apollo landing sites, where astronauts landed more than 30 years ago. Then the telescope observed another site where astronauts did not land: the young Aristarchus impact crater and the adjacent Schroter's Valley rille. The ultraviolet light from that site looks somewhat like the light taken from the Apollo landing sites, indicating that Aristarchus and Schroter's Valley could contain some of the titanium oxides that future Moon pioneers will need to produce oxygen (see photos, top of page 3).

This observation marks the first time that Hubble has assisted in human space exploration. Scientists normally use the telescope to study more distant objects such as other galaxies and dying stars.

Looking at the Moon is not an easy task for Hubble. The Moon moves across the sky very quickly, making it difficult for Hubble to follow its path. So why was Hubble used?



IMAGES: NASA, ESA, and J. Garvin (NASA/GSFC)

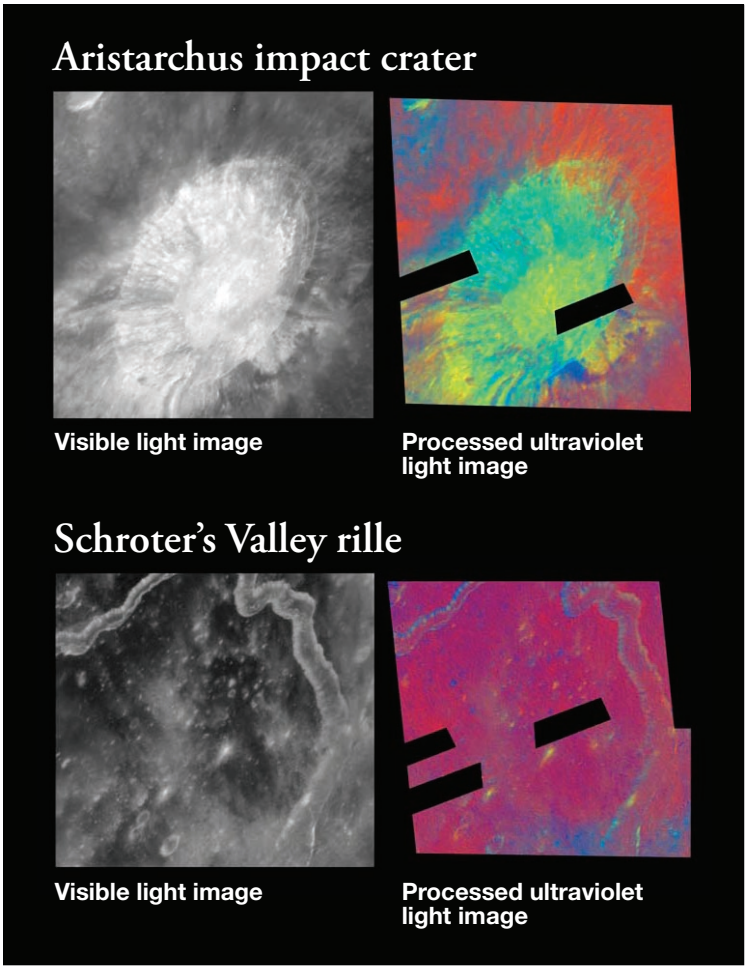
Hubble's lunar observations:
Hubble studied these three sites on the Moon. Scientists used Hubble's ultraviolet photos of these sites and moon rocks and soil gathered in the 1970s during the Apollo missions to help them identify the minerals at these sites.

The Aristarchus crater (leftmost photo) and the nearby Schroter's Valley rille have never been visited by man or robot.

Staying above it all

The answer has two parts: First, the Earth's atmosphere absorbs some ultraviolet light, so not all of the light reaches the ground (see illustration, page 3). A telescope in space, like Hubble, is above the atmosphere and can collect the ultraviolet light.

Second, the Moon is so dim in ultraviolet light that it took sensitive instruments like Hubble's to see it. Even so, Hubble had to look for a long time to collect enough light to make the images. ★



IMAGES: NASA, ESA, and J. Garvin (NASA/GSFC)
(NOTE: Black bars in the ultraviolet images represent areas where no data were taken.)

Using the Hubble Space Telescope to find oxygen-rich minerals on the Moon

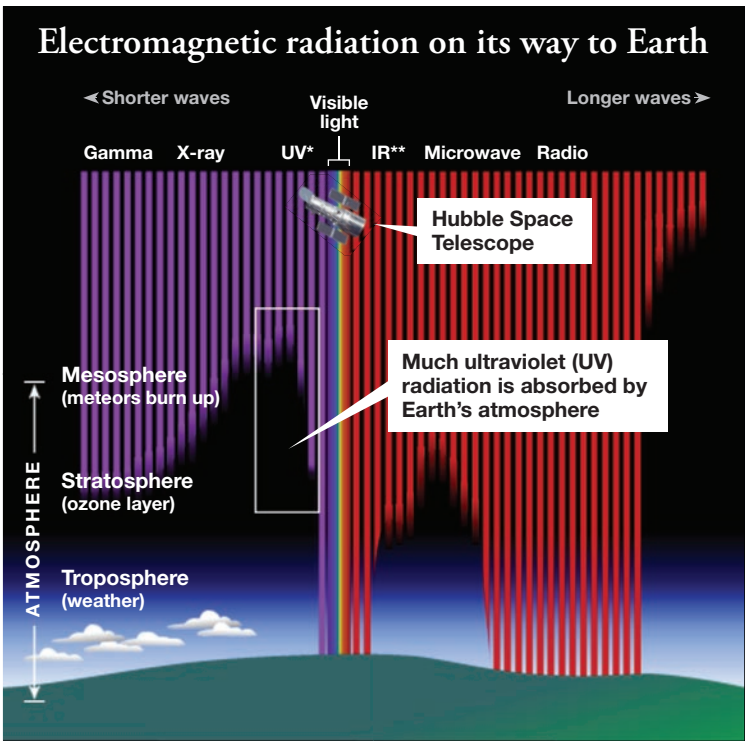
Reflected light is a tool astronomers use to study objects in space. In this case, they compared visible- and ultraviolet-light images of the Moon.

Different minerals reflect varying amounts of ultraviolet light. This fact enabled scientists to identify oxygen-rich minerals like titanium oxides on the Moon's surface.

The visible-light image (top, left) is Aristarchus, one of the largest and youngest impact craters on the Moon. Many of the crater's fresh impact features are still well preserved.

Scientists used a special technique to colorize the ultraviolet image at top, right. The colors reveal a variety of minerals. Scientists suspect that the bluer areas may be ilmenite — a mineral composed of titanium, oxygen, and iron.

The visible-light image (bottom, left) of Schroter's Valley shows a meandering "rille" (a long, narrow, depression). Notice how the blue color in the processed ultraviolet image (bottom, right) follows the shape of the rille. The blue areas may be resource-rich material.



Above Earth's atmosphere, the viewing is good

Most wavelengths of light never reach Earth's surface. They are absorbed by our atmosphere.

Ultraviolet (UV) radiation is absorbed in or near our upper atmosphere, especially near the ozone layer. The Hubble Space Telescope, placed far above our atmosphere, is in a perfect position to observe the faint ultraviolet light from the Moon.

NOTES: All distances are approximate. Boundary of the atmosphere is approximate. The space telescope is not shown at its actual altitude above the atmosphere. Altitude scale is logarithmic.

*Ultraviolet light **Infrared light

SOURCES: Chandra mission website and Space Telescope Science Institute

SEE MORE Hubble images and read more
Star Witness news stories at Amazing Space,
NASA's award-winning educational Web site for
K-12 students and teachers.

amazing-space.stsci.edu