Lunar Reconnaissance Orbiter to peer into history

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SPACEFLIGHT NOW
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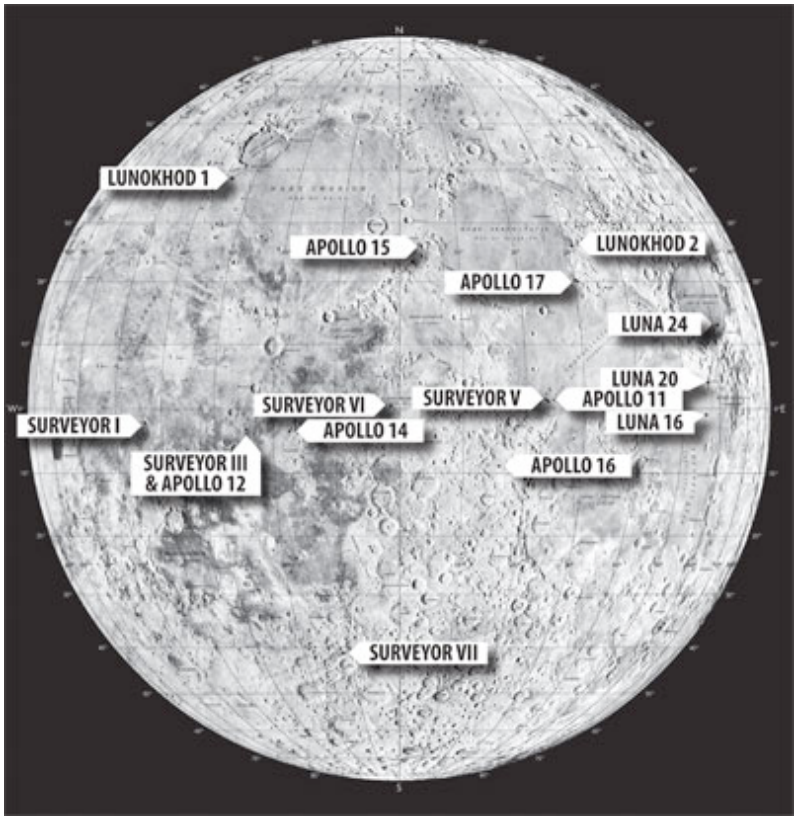
Factors of time and distance have obscured from view the winners and losers that remain across one of the great battlegrounds of the Cold War - the Moon.

Those interfering veils are about to be lifted by NASA's Lunar Reconnaissance Orbiter (LRO), set for liftoff June 17 on the most ambitious lunar mission since Apollo 17 in 1972.

LRO is a science mission with tremendous implications for future manned and unmanned missions to the Moon.



Credit: Lunar And Planetary Institute/Spaceflight Now

Its accompanying Ames Research Center /Northrop Grumman Lunar Crater Observing and Sensing Satellite (and Centaur upper stage impactor) could also help discover water

ice critical for future lunar outposts.

But LRO will also provide an exciting new window on the past, says Craig Tooley, LRO project manager at the Goddard Space Flight Center which heads the project.

The LRO team has been developing a computerized target list "with coordinates on about 50 high priority locations that involve all six Apollo landing sites and dozens of U. S. and Soviet robotic spacecraft touchdown points," says Benjamin J. Neumann director for advanced capabilities at NASA Œs Exploration Mission Directorate.

"We will be in a polar orbit that will overfly everything that has ever landed on the Moon at only 50 km. (31 mi.) altitude," says Cathy Peddie the LRO deputy project manager at Goddard.

Importantly this will help provide the geologic context that has been lacking for especially the robotic missions that succeeded, says Tooley.

Key targets involve:

- Apollo landing sites: LRO's imagery will help show detail on the condition of all six Apollo landing sites and the Apollo flight hardware left on the moon by 12 American astronauts between 1969-72.

The LRO mission is launching just as the 40th anniversary of Apollo 11's first manned lunar landing approaches on July 20.

Whether images of the Sea of Tranquility site explored by Neil Armstrong and Buzz Aldrin in 1969 will be taken by then, will depend on many LRO mission timing events yet to be determined. But the Goddard team is going to try to obtain such imagery in time for the Apollo 11 anniversary if that can be done without disrupting primary LRO mission operations.

- Lunar Mission Mysteries: LRO's new images should help solve some old mysteries, like where did the first Soviet Lunokhod rover end up. The eight wheeled, 1 ton marvel drove for 322 Earth days and about 6.5 miles before dying so suddenly that its control team was unable to configure its laser retorreflector that would have yielded an exact location.

The images may also show what ever happened to the U. S. Surveyor 4 lander that in July 1967 stopped transmitting just before landing and presumably crashed-but nobody knows.

And LRO may show what happened to the Soviet unmanned

lunar sample return spacecraft that crashed in mid July 1969 trying to beat Apollo 11 with the return to Earth of at least robotically obtained Moon dust.

If the Apollo 14 astronauts scuffed up the soil enough, LRO may also show how close Alan Shepard and Ed Mitchell got to the rim of Cone Crater. Exhausted they were forced to turn back only an estimated 100 ft. from what would have been one of the great scenes of Apollo, but invisible to them due to the looming drop-off.

- Geologic context: There is also important science to be obtained from imaging especially the Apollo sites, says Mike Wargo LRO program scientist at NASA Headquarters. Those sites were imaged at the time in exquisite detail by the Apollo crews themselves and spacecraft like the Boeing Lunar orbiters.

LRO's even greater imaging capability and modern computer capabilities should provide precise new detail on the amount of meteorite and micrometeorite cratering that has occurred over the last 40 years.

Although just a split second in geologic time, science managers like Mark Robinson, principal investigator for the Lunar Reconnaissance Orbiter Camera developed at Arizona State University, believe the data can show changes like additional roughness that may have occurred in the Apollo areas.

"It may not look like much difference now, but it could be very important for the long term habitability and survivability of crews based later in lunar outposts. Wargo says.

Also of geologic interest will be the craters left by impacts of discarded Lunar Module ascent stages and S-4B Saturn upper stages deliberately targeted to hit the Moon to cause moonquakes that would be detected by seismometers left by the crews.

The general public will be asked to submit more target ideas to the LRO project website.

The geologic areas surrounding the Soviet Luna 16, Luna 20 and Luna 24 sample return spacecraft will also be imaged to perhaps see the descent stages in the midst of the surface terrain. All three returned small lunar soil samples to Earth.

The tracks made by the Lunokhod 1 rover during 6.5 mi. of driving in the Sea of Rains and Lunokhod 2's remarkable 23 miles of roving in hilly regions of the crater Le Monnier will also attempt to be imaged.

Although success will depend on lighting conditions says Robinson at Arizona State. He noted that "this would be more likely under high Sun angles since the tracks will have disturbed the regolith and have a different reflective character."

The launch itself on an Atlas V will be one of ironies from the cold war.

The Atlas V will be powered by a 1 million lb. thrust RD-180 Russian rocket engine produced in the Energomash rocket plant targeted for U. S. destruction had the Cold War gone hot.

Russian rocket scientists at the Cape will be in a room walled off for commercial, not military security, to monitor their engine's performance.

It will be the first time that a Russian rocket engine has propelled anything toward the Moon in 33 years-and it will be from Cape Canaveral instead of the Baikonur Cosmodrome where virtually all Russian robotic missions to the Moon were launched.

LRO has nine instruments, the cameras being key to the location of human made artifacts.

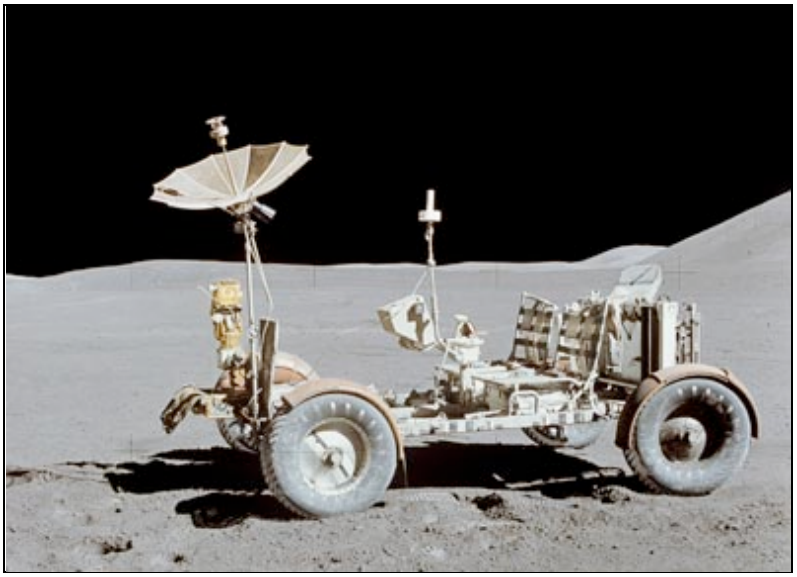
The Lunar Reconnaissance Orbiter Camera (LROC) is designed to address two of the prime LRO measurement requirements: 1) Assess meter scale features to facilitate selection of future landing sites on the Moon. 2) Acquire images of the poles every orbit to characterize the polar illumination environment (100 meter scale), identifying regions of permanent shadow and permanent or near-permanent illumination over a full lunar year.

In addition to these two main objectives, the LROC team plans to conduct meter-scale mapping of polar regions, 3-dimensional observations to enable derivation of meter-scale surface features, global multi-spectral imaging, and produce a global landform map.

LROC consists of two Narrow Angle Cameras (NACs) to provide 0.5 meter-scale panchromatic images over a 5 km swath, a Wide Angle Camera (WAC) to provide images at a scale of 100 meters/pixel in seven color bands over a 60 km swath, and a Sequence and Compressor System (SCS) supporting data acquisition for both cameras.

The system is a modified version of the Mars Reconnaissance Orbiters ConTeXt Camera (CTX) and MARs Color Imager (MARCI) provided by Malin Space Science

Systems (MSSS) in San Diego, CA.

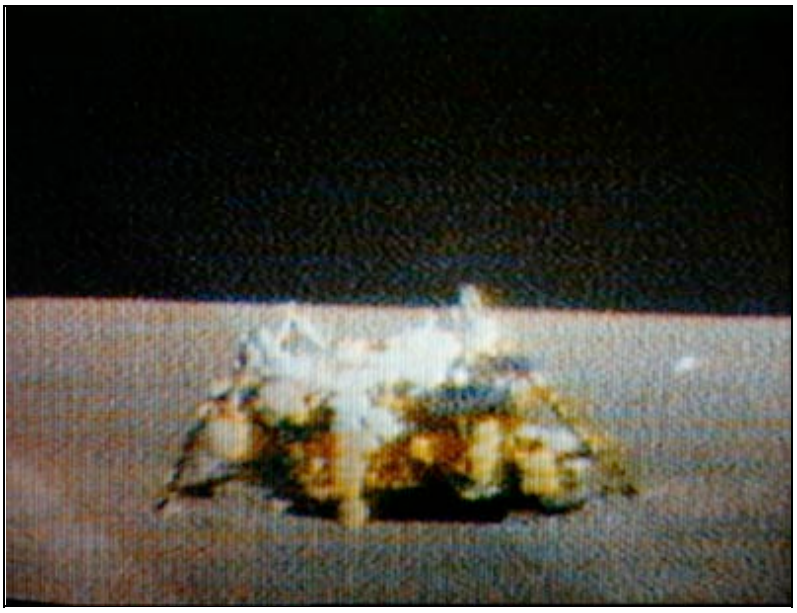


The Boeing built lunar rover used on the later Apollo missions. Credit: NASA

How much detail the cameras will provide on the condition of the Grumman Apollo Lunar Module Descent Stages and Boeing lunar rover cars will depend on lighting conditions, look angles and LRO's 18 in highest resolution capability.

Robinson notes that in some cases it will be the shadows of the object that will show up better than the spacecraft themselves.

The Apollo descent stage decks should be somewhat visible as they are 8x8 pixels wide with a deck size of 4.3 meters. The imager can see down to 0.5m/pixels.

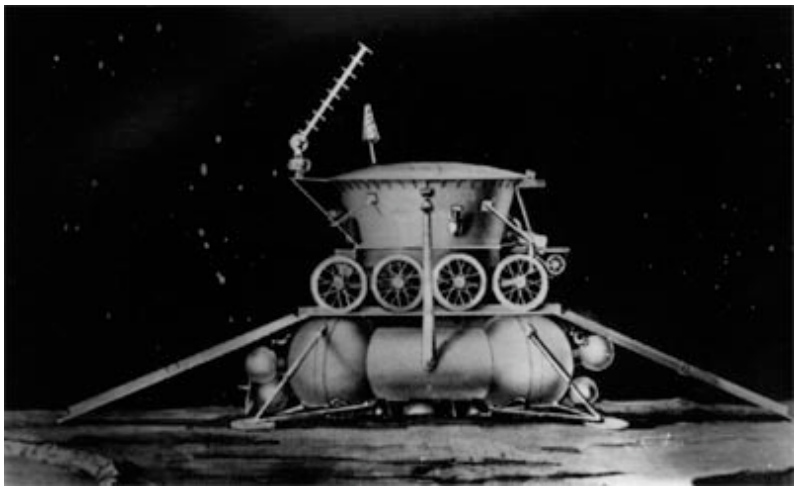


The Apollo 15 lunar module decent stage left behind on the surface seen from the lunar rover TV camera. Credit: NASA

The tracks of astronauts will be impossible to see, but if the ground was highly scuffed over large areas like around parked rovers, that perhaps could be seen as should be surface scouring by the Lunar Module descent engine during landing.

LRO will search for, and likely find the historic 1 ton eight wheeled Lunokhod 1 rover that has been lost in the Sea of Rains since driving for 6.5 miles over 322 earth days in 1970-71.

When it failed the spacecraft's laser retroreflector was not accurately pointed, so while the USSR knew approximately where it was, the specific location where it died remains unknown.



Artist's impression of Russia's Lunokhod rover. Credit: NASA

The renowned Lavochkin design bureau built the Lunokhod rovers , the Soviet Luna sample return spacecraft and other historic Soviet planetary spacecraft.

Lunokhod 2 will be imaged and is of special interest to International Space Station Soyuz mission space tourist astronaut Richard Garriott, the son of NASA Skylab and shuttle astronaut Owen Garriott.

An internet millionaire, Richard Garriott bought Lunokhod 2 rover from Lavochkin for $68,500 at a Sotheby's auction in New York in December 1993.

All of the Lavochkin spacecraft that remain on the moon, including Luna 9 - history's first soft lander - apparently remain the properly of Lavochkin.

Luna 9 with its ball shape and fold down petals revealing a camera mast will be a high priority LRO target because of its place in history.

This is like the Soviet history that surrounds the Lunokhod rovers with their ramped descent stages and the sample return spheres that made a successful 500,000 mi. roundtrip between Earth and the Moon.

In Moscow, Lavochkin maintains one of the great space museums of the world, earlier available for viewing only by advance appointment.

On my visit there I was shown around by the same Lavochkin employee who had strapped cosmonaut Yuri Gagarin into his Vostok 1 spacecraft for the first human flight into space.

I was awed by just that. Then he topped it by handing me a black basketball sized sphere. It was the return capsule for Luna 24, the final robotic sample return from the lunar surface.

"Its been on the Moon," he said with appropriate reverence. Have you ever touched anything that has been on the Moon before?"

I almost did not have the heart to answer him. "Yes," I said, "Neil Armstrong."

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