The Lunar South Pole: Explore the Unexplored

A rugged and fascinatingly cold terrain awaits our exploration of the Moon.

Littered with impact craters, the terrain of the lunar south polar region is more rugged than any encountered by the Apollo astronauts. With few exceptions, the surface of this region has remained unchanged for nearly 3 billion years.

In polar regions, the sun always appears low on the horizon, leaving portions of the surface in constant shadow. Known as permanently shadowed regions (PSRs), these regions never receive sunlight.

Image Caption:
Game of Shadows *Though all of the walls of the crater may be illuminated as the Sun moves across the sky (panels from left to right), a portion of the crater floor may remain in shadow (red). Credit: LPI.*

Rock samples collected here may represent the oldest pieces of the Moon's crust – revealing how long ago the Moon's crust solidified. These samples may also help constrain the age of the South Pole – Aitken basin, the Moon's oldest and largest impact basin.

Image Caption:
COLD! *Temperatures in PSRs have been measured by spacecraft to be as low as 23 Kelvin (-250° Celsius). Credit: LPI.*

Successfully exploring the Moon's surface and locating valuable rock samples for scientific study can be enhanced by the use of resources found on the Moon.

Image Caption:
Lunar Surface Extravehicular Activity (EVA) *A robotic asset and two astronauts in a walking EVA in sight of their lander (background). Art by Daniel D. Durda.*

Water on the Moon: Small amounts, big potential.

The Moon acquired water in its interior by asteroid and (to a lesser degree) comet impacts while the Moon was still partially molten. After the crust cooled and solidified, additional impacts delivered water to the lunar surface while volcanic eruptions brought interior water to the surface where it eventually settled in PSRs and other very cold regions at the lunar poles.

Image Caption:
Lunar Water Sources *Although comets may contain more water (perhaps 50%) than asteroids, their isotopic compositions do not match that of the Moon's volatiles. Asteroids were the dominant source of water. Credit: LPI.*

Image Caption:
Ancient Lunar Atmosphere *Volcanic eruptions on the Moon 3.5 billion years ago brought water to the surface and may have formed a temporary lunar atmosphere. Credit: NASA Marshall Space Flight Center.*

Image Caption:
Computer-generated Image of the Solar Wind *In addition to past volcanic and impact sources of water, the solar wind chemically reacts with the lunar surface to provide an ongoing source of surface water. Credits: ESA&NASA/SOHO.*

Image Caption:
Water at the South Pole *Observations by NASA's Lunar Reconnaissance Orbiter have measured water ice signatures at the lunar surface in the lunar polar regions. This graphic outlines the locations of water ice in the south polar region. Credit: NASA Goddard Space Flight Center Scientific Visualization Studio.*

Sustainable exploration of the Moon will be enhanced if the existence of this ice, and the ability to harvest it for use as drinking water, fuel, and radiation shielding, can be confirmed.

Lunar experts are developing methods to study ice on the Moon's surface.

Dr. Julie Stopar and Dr. David Kring of the Lunar and Planetary Institute (LPI) are creating maps for inclusion in LPI's *Lunar South Pole Atlas*, a collection of maps (as well as images and illustrations) of the lunar south polar region. These resources are assisting NASA and the lunar science community preparing to explore the Moon.

Image Caption:
Rugged and Cold *This topographic map of the lunar south polar region reveals its rugged terrain of high and low points. Locations of large PSRs (those larger than 10km^2) are shown in gray outlines. Credit: LPI.*

This map and others are available in the *Lunar South Pole Atlas* at www.lpi.usra.edu/lunar/lunar-south-pole-atlas.

Aaron Paz and Lara Oryshchyn are building instruments at Johnson Space Center for NASA's exploration and processing of resources. These instruments will extract and analyze water and other volatile substances from lunar soils. Those substances may be ices, but the team is also developing methods for producing water from rocky components in the soil.

Image Caption:
Testing in Lunar Gravity Conditions *Aaron and Lara testing a method to use hydrogen to extract water from lunar soils. The experiment occurred in an aircraft (inset) that climbed then dove to reach a speed sufficient to simulate reduced lunar gravity (1/6 g) conditions. Credit: NASA.*

This exhibit was developed by the Center for Lunar Science and Exploration (www.lpi.usra.edu/exploration) of the NASA Solar System Exploration Research Virtual Institute.