Lunar CRater Observation and Sensing Satellite

Methods of Water Detection

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The principal mission objective of the Lunar CRater Observation and Sensing Satellite (LCROSS) is to confirm the presence or absence of water ice that might have amassed in the large shadowed craters near the lunar poles. (These craters, being permanently in shadow, are the coldest spots on the Moon, and over many years scientists think it is possible for ice to collect there.) This new information will provide critical research data for the Lunar Prospector and Lunar Reconnaissance Orbiter (LRO) lunar maps, making it feasible to evaluate the total lunar water inventory and to provide significant insight into the cosmic processes that delivered hydrogen to the polar regions of the moon. Several theories currently circulate around the scientific world on possible ways water could have collected on the Moon and also Mars. The LCROSS mission should decisively conclude the debate and signify the actual answer to the question. Whatever the mechanism for the delivery and possible retention of lunar water, interest in the possible presence of water ice has both scientific and operational significance. If water is present in the upper meters of the lunar crust to the few percent level, LCROSS will find it by using a kinetic impactor termed the Atlas V Centaur rocket to excavate more than 250 metric tons of rock. The thermal and spectral signature of the impact flash and the expelled crater material that gets launched into sunlight will be studied in detail, and the results transmitted to Earth before the large shepherding spacecraft also impacts the Moon. These two impact experiments and their aftermaths will also be observed from a number of Lunar-orbital and Earth-based assets and provide the desired information about the amount of water.

Combining several independent measurement methods greatly increases the probability of obtaining a precise and definitive understanding of the impact event and the amount of water contained in the region. Furthermore, many of these measurements, because of their instrument requirements or the timescale of the physical process, are more effectively made either from an area very near the event such as the Shepherding Spacecraft or from ground-based telescopes. Combining measurements from the Shepherding Spacecraft with ground-based observations and subsequent mapping by lunar orbiting satellites, like the LRO, enhances the overall strength and effectiveness of the LCROSS mission.

Achievement of the LCROSS mission is subject to some moderate risks. The primary risk factor is that the shadowed crater may be sufficiently non-uniform in terms of its hydrogen content to the point that even two impacts may not guarantee results that are definitive with respect to planning for subsequent landing missions. In analyzing this risk NASA scientists have used the conservative estimate that only 5% of the excavated crater mass is ejected into the observable plume. Even with these conservative numbers, the scientists believe that if ice deposits exist, the slight amount of water will be detectable to both orbital satellites and telescopes and also to ground-based observers. It is possible but highly unlikely that the two impactors may hit sites lacking any evident hydrogen or water ice deposit. The concern is one of how to interpret the results if no water is observed in the dust clouds that rise from the impact events. In such a case, the high-tech neutron and radar mapping data acquired by the LRO, will be important in understanding the LCROSS results in deciding whether the impact sites are abnormal regions or not.

In almost any outcome, the results obtained by LCROSS will provide decisive information regarding the distribution and nature of water on the Moon. In all cases, LCROSS will provide valuable knowledge regarding the Lunar Polar crater properties, environment, and impact processes. This information will be valuable in determining how lunar missions in the future will proceed.