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MODELING LONG TERM DEPOSITION OF ICE IN LUNAR PERMANENTLY SHADOWED REGIONS (PSRS) FOR THE PURPOSES OF RESOURCE PROSPECTING

Abstract

Recent discoveries of concentrated ice and volatiles in permanently shadowed regions (PSRs) on the Moon have raised questions as to the origin of said ice and volatiles, their diminishment over time, and the likelihood of their replenishment from outside the Moon by comets and meteors. Data from the Lunar Crater Observation and Sensing Satellite (LCROSS) and ISRO's Chandrayaan-1 satellite indicated substantial quantities of water ice, hydrocarbons, and other useful compounds in the PSRs. However, this finding takes on even greater significance in the light of recent modeling indicating that these resources would have sublimated into space over the course of the Moon's lifetime in the absence of replenishment from without. To model the latter and complete this picture, the authors have created a 3-D Monte Carlo simulation model of bombardment of the PSRs over time taking into account the PSR environment, diffusion of ice into lunar regolith, and current data regarding meteorite and comet composition, trajectory, and likely impact on the lunar surface over time. Partial verification of the model was performed using Chandrayaan-1 data, and additional comparison of the results was made to the LCROSS data. Over time and with further verification, this model could serve as a useful predictive tool for resource prospectors hoping to locate and harvest the ice, hydrocarbons, carbon dioxide, and other useful compounds in the PSRs, as well as to build preliminary lunar resource business plans and concepts of operation based on this model.