

# Topographic and Geological Analysis for Future Water Exploration in the Lunar Polar Regions

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The presence of water in the lunar polar regions has been strongly suggested by multiple recent explorations, including those by Lunar Prospector and LCROSS. It is believed that lunar water exists mainly in permanently shadowed regions near the poles, where sunlight does not reach and temperatures remain extremely low. However, the exact distribution and quantity of lunar water remain unclear. The primary source of lunar water are thought to be asteroid and comet impacts, as well as implantation of solar wind. Understanding the mechanisms of water delivery and accumulation is essential for gaining valuable insights into the processes of water transport in the solar system. Additionally, investigating lunar water is crucial for evaluating its potential as a resource for future lunar exploration, such as its use as a fuel source.

To address these questions, multiple exploration missions have been planned to investigate the distribution and quantity of water on the Moon. For example, JAXA, in collaboration with Indian Space Research Organisation (ISRO), is advancing the Lunar Polar Exploration (LUPEX) project. This mission aims to explore the lunar south polar region using a rover to excavate regolith and conduct in situ analysis to determine the distribution and quantity of water. In order to extrapolate the limited results from such localized lunar polar explorations to estimate the overall distribution of water, it is necessary to understand the relationship between water quantity and the surrounding topographical and geological conditions. To achieve this, exploration sites must be carefully selected to cover diverse conditions.

In this study, we conducted a detailed analysis of the topographical and geological environment at one of the candidate sites for future lunar polar exploration to identify the most suitable exploration locations. First, using high-resolution image from Chandrayaan-2, we estimated the age of the target exploration area based on crater chronology. The results revealed significant deposition events approximately 100 million years ago and 1 billion years ago, and the deposition thicknesses were also estimated to be 2m and 40~50m respectively.

Next, we used topographic data from the Lunar Reconnaissance Orbiter (LRO) to calculate the depth-to-diameter ratios of 25 selected craters and the slope of the surrounding surface. Additionally, using a diffusion equation, simulations of crater degradation was conducted considering the surface slope, and the formation age of each crater was estimated using these results.

Finally, we selected three craters with differing topographical and geological conditions and investigated the specific stratigraphic structures around them, as well as the potential locations where water might exist. Exploration of these craters is expected to detect water from a wide range of geological ages.

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