Geological mapping of the peak near Shackleton Crater: Implications for mission success in human landing operations

Olufunke Adepoju

TTU Geosciences

Peak Near Shackleton (PNS) offers several advantages as a lunar mission site. Situated on the rim of the South Pole-Aitken (SPA) basin, the Moon's largest and oldest impact structure, the region exhibits rugged, heavily cratered terrain typical of the southern highlands. The South Pole resides on an inner SPA basin massif, rising 1-2.5 km above the lunar radius. PNS is a prominent Artemis III landing site candidate due to its topography, geology, and potential for volatiles. Its location provides unique lighting and long-duration solar exposure essential for sustained operations. Understanding the area's geology informs lunar history and crustal evolution. Permanently shadowed regions suggest volatile preservation, beneficial for in-situ resource utilization (ISRU). Diverse surface units allow lunar stratigraphy and impact history studies.

Photogeological analyses utilized high-resolution Lunar Reconnaissance Orbiter (LRO) data, including Narrow Angle Camera (NAC) mosaics (1m/pixel) and Lunar Orbiter Laser Altimeter (LOLA) Digital Elevation Models (5m/pixel), processed in ArcGIS. Image interpretation elements like tone, texture, elevation, albedo, and geographic positioning were employed to construct a detailed geomorphological and topographic assessment. A 1:10,000 scale geologic map identified 24 units grouped into six categories, including unnamed crater, crater ejecta, Shackleton, Terra, Slater, and Highland units, spanning Pre-Nectarian to Copernican periods. The study cataloged 343 linear features, such as crater rims (<5 km), boulders, lineaments, depression margins, and scarps, alongside two surface feature types. These characteristics enhance understanding of lunar tectonics, impact processes, and surface evolution. Based on slope gradients and landing radius, three potential landing zones were identified.

PNS is a geologically diverse and strategically significant region with essential science targets for Artemis missions. The site's proximity to the South Pole offers unique lighting and extended sunlight, and the potential for volatile deposits combined with favorable landing conditions makes it a prime candidate for NASA's Artemis program and future lunar endeavors.