



Lunar Geotechnical Investigation Protocols

Preliminary Guidelines for Robotic and Human-Assisted Site Characterization

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Overview

Geotechnical investigation is a fundamental prerequisite for any lunar infrastructure program where excavation, construction, or in-situ resource utilization (ISRU) is planned. The Moon presents unique challenges, including variable regolith stratigraphy, limited ground truth data, and the absence of atmospheric and hydrological processes that influence terrestrial soils.

This document provides a **provisional framework** for site investigation methodologies aimed at characterizing regolith depth, mechanical consistency, and subsurface anomalies. The recommended approaches leverage robotic systems adapted from terrestrial geotechnical engineering practices but recalibrated to account for lunar gravity, vacuum conditions, and electrostatic surface behavior. The protocols outlined herein are intended to support early-stage site selection, excavation planning, and risk mitigation strategies essential for the safe and efficient development of lunar surface infrastructure.

Standard Protocols and Techniques for the Early Stages

1. Ground Penetrating Radar (GPR)

- Used for vertical profiling and detecting shallow subsurface structures
- Effective in mare and highland transition zones
- Operates best with low-frequency antennas (5–100 MHz)
- Identifies reflectors associated with regolith stratification and buried rocks

2. Cone Penetrometer Testing (CPT)

- Utilizes robotic or tethered rigs with force sensors
- Captures resistance and stratigraphy down to 2–3 meters
- Distinguishes compaction changes and boulder presence
- Ideal for classifying regolith behavior across excavation zones (L1–L3)