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DETERMINING AGES OF ROCKS ACCESSIBLE WITHIN THE ARTEMIS EXPLORATION ZONE

Abstract

NASA's Artemis program aims to explore impact-cratered terrain near the lunar south pole to address fundamental questions about the Moon's formation and evolution. This study integrates spectral data, crater counting models, and maps to establish a framework for chronological efforts on potential landing sites. The Kaguya Spectral Profiler (SP) is employed to analyze lithologies and compositions, focusing on anorthositic, mafic, ultramafic, basaltic, and impact-related materials.

The study reveals that potential landing sites exhibit a feldspathic terrain with various lithologies, primarily anorthositic norite/gabbro/troctolite and anorthositic norite/gabbro/troctolite. Chronological considerations for anorthositic lithologies involve Sm-Nd, U-Pb, and Rb-Sr analyses, while mafic lithologies offer broader chronologic options, including uranium-rich trace phases. Ultramafic lithologies are limited in chronologic options, with Re-Os, Lu-Hf, and Sm-Nd being potential approaches. Basaltic materials, representing early lunar volcanism, can be dated using U-rich accessory phases or Ar-Ar, while impact melts and breccias rely on Ar-Ar and U-Pb systems.

The study emphasizes the importance of chronological precision in addressing questions about lunar history. Anorthositic lithologies, associated with lunar magma ocean processes, may require diverse dating methods due to impact processing. Mafic lithologies offer insights into magmatic differentiation events, with uranium-rich trace phases providing precise chronology. Ultramafic rocks, mostly found at depth, present limited chronologic options. Basaltic materials and impact-related samples, including breccias, require specialized dating approaches due to complex thermal and shock effects.

The return sample collection strategy for Artemis differs from Apollo, allowing for diverse sample types regardless of grain size. Crews can focus on collecting impact melts for precise dating of impact events and norites for understanding early Moon system evolution. Brecciated samples may contain fragments of rare mantle materials. Technological advancements enable a more flexible approach to sample collection, expanding the range of geochemical materials available for analysis. Overall, this study provides a comprehensive framework for developing chronological efforts on lunar samples collected during the Artemis program.