

OPTIMIZING LUNAR RESOURCE EXTRACTION: CUT-OFF GRADES FOR RESERVES ESTIMATION. Carlos Daniel Espejel Garcia, Space RS S.a.r.l., carlos.espejel@space-rs.com.

Introduction: Space RS is a pioneering consulting and technology firm based in Luxembourg, specializing in the integration of terrestrial mining expertise with space industry innovations, supporting both terrestrial mining and the Space Resource Utilization (SRU) and In-Situ Resource Utilization (ISRU) sectors. As the space economy advances, value chain optimization emerges as a critical factor for successful resource extraction and utilization beyond Earth. This work explores the adaptation of terrestrial mining methodologies—such as value chain optimization, reserves estimation [1], and cut-off grade determination [2]—to the space resource sector, particularly within the Cislunar economy.

Cut-Off Grade (COG) Determination: One fundamental aspect of reserves evaluation is value chain optimization and the determination of cut-off grades, which dictate the economic feasibility of extraction and processing. This work explores their adaptation to SRU and ISRU. Cut-off grade serves as a key threshold for determining the economic viability of resource extraction [2]. Cut-off grades can dynamically adjust based on mission constraints, resource availability, processing efficiency, and energy consumption, allowing for greater flexibility in ISRU operations and improved overall resource recovery. By leveraging established mining evaluation techniques such as cut-off grades, SRU and ISRU operations can make informed decisions regarding material extraction and processing. This approach enhances the economic feasibility of space resource activities, ensuring that extracted materials contribute positively and effectively to mission profitability and sustainability.

Value Chain Optimization in ISRU: Effective resource management in space requires a holistic approach that integrates exploration, extraction, processing, and end-use applications. Value chain optimization enables ISRU stakeholders to streamline operations, minimize waste, minimize cost, maximize value, and therefore maximize resource efficiency. This strategic alignment not only improves economic outcomes but also promotes sustainability in space activities. Additionally, value chain optimization should consider environmental, social and operational constraints unique to space, this framework ensures that ISRU operations remain scalable and adaptable to evolving technological, legal and market advancements.

Conclusion: The successful implementation of ISRU depends on the careful integration of terrestrial mining principles with space industry innovations.

Optimizing the space resource value chain and accurately estimating reserves through cut-off grade determination will play a pivotal role in shaping a sustainable and economically viable Cislunar economy. By applying these methodologies, ISRU can transition from theoretical models to practical, mission-ready operations, supporting long-term human and robotic exploration beyond Earth.

References: [1] Viorel Badescu et al. (2023) Handbook of Space Resources. [2] Kenneth F. Lane (2015) The Economic Definition of Ore, 1-50.