

AN AREA-BASED MANAGEMENT APPROACH FOR MANAGING LUNAR MINING ACTIVITIES. K.M. Hubbard^{1*} and L.T. Elkins-Tanton¹. ¹Arizona State University, 781 Terrace Mall. Tempe, AZ 85281. (k.m.h@asu.edu)*

Introduction: The development of lunar mineral resources is hindered by two major factors: 1) the absence of an institution and instrument for issuing long term exclusive rights to explore and exploit the Moon for its resources and 2) a process by which a title could be acquired to explore and exploit an area and claim its resources. A case study was conducted on the International Seabed Authority's (ISA) management of seabed minerals to identify best policies and practices for implementation in Area-Based Management of lunar mineral resources. The case study includes an analysis of the ISA's 1) historical development and negotiating history, 2) guiding principles, 3) its 'Mining Code' [3], and 4) its Environmental Management Plan for the Clarion Clipperton Fracture Zone.

We recommend governing Lunar mining activities using a contract system and Area-Based Management Tools. Both require a designated authority to implement and oversee rules, regulations, and procedures in specified areas requiring higher protection or restrictions [1]. A Lunar Spatial Planning Tool (Figure 1) was developed to facilitate the implementation of such strategies on the lunar surface.

The Lack of a Lunar Governance Regime: We recommend the development of a Lunar Resource Management Authority (LRMA), an intergovernmental regime responsible for: i) encouraging the development of lunar resources, ii) developing and administering area-based management strategies, iii) safeguarding the lunar environment as it may be affected by mining activities, and iv) ensuring the equitable use and economic benefits of lunar mineral resources. The regime would be a United Nations governing body.

Regulations, Policies, and Procedures: We recommended the following for overseeing Lunar mining activities: 1) a notification process for prospecting, where a lunar contractor must notify the LRMA of its intention to engage in prospecting, 2) a contract system, where the LRMA would issue exclusive but temporary rights over a limited number of mining blocks on the Moon's surface, providing security of tenure, 3) the use of Reserved Areas, an equitable management strategy that reserves mining areas for non-space faring nations, which are partitioned from each contract area granted to a Lunar contractor, 4) a "Relinquishment" procedure, both for resolving overlapping contract areas and for a contractor to delineate Reserved Areas, 5) the development and use of Areas of Particular Scientific Interest, where Preservation Reference Areas and Impact Reference

Zones will be implemented to safeguard the lunar environment, 6) the development and implementation of Areas of Particular Operational Interest in areas where mining activities are prohibited since the locations are requisite to other sectors, and the 7) the incorporation of priority rights and first possession principles [4] for the "Pioneer Investors" that invest in the early development of lunar mineral resources.

The Lunar Spatial Planning Tool: We propose a Lunar Spatial Planning Tool (Figure 1) based on temperature, slope, and access to power and communications to support the development and implementation of a contract system and Area-Based Management measures. The tool divides a defined resource system—in this case, it is the South Pole from 80° poleward—into a grid of ~1km² mining blocks. By simplifying the lunar surface into blocks, the tool facilitates the recognition of rights and compliance and enforcement of the recommended rules, regulations, and procedures listed above.

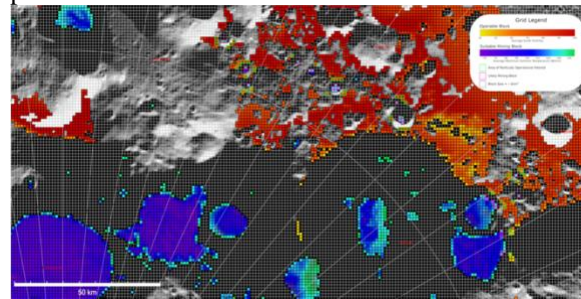


Figure 1 - Example of the Lunar Spatial Planning Tool dividing the Lunar South Pole into a grid of ~1km² mining blocks overlaid on a morphologic base map (100 m/pixel scales) produced by the LROC WAC aboard the Lunar Reconnaissance Orbiter [5]. Suitable mining blocks are classified according to their average summer maximum temperature [6] and navigability. Operable blocks are classified according to their average solar illumination [7], Earth visibility [7], and navigability. Mining blocks outlined in pink are deemed prime real estate based on their proximity to an operable block. Operable blocks outlined in lime green are classified as Areas of Particular Operational Interest, where mining activities should be restricted.

References: [1] Gissi, E. et al. (2022). *Journal of Cleaner Production*, 330, 129910. [2] UN Doc. A/62/66/Add.2, 122–161. [3] ISA. Consolidated Regulations and Recommendations on Prospecting and Exploration. (2015). [4] Gruner, B.C. (2004). *Seton Hall Law Review*, 35, 1. [5] Robinson, M.S. (2012). *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, XXXIX-B4, 501-504. [6] Williams, J.P. et al. (2019). *JGR Planets*. 124, 2505-2521. [7] Mazarico, E. et al. (2011). *Icarus*, 211, 1066-1081.