

34th IAA SYMPOSIUM ON SPACE AND SOCIETY (E5)
Interactive Presentations - 34th IAA SYMPOSIUM ON SPACE AND SOCIETY (IP)

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ISRU: THE PATHWAY TO SUPER-SUSTAINABLE MINING OPERATIONS ON EARTH AND SPACE

Abstract

For thousands of years, humans have explored and extracted geological resources to advance our society and technology. Now with the goal of making long-term space missions feasible, the focus is on the development of In Situ Resource Utilisation (ISRU) capabilities to seek, extract, and utilise planetary space resources.

To inform and accelerate this ISRU development activity, important opportunities exist to learn from existing sustainable terrestrial mining practices. With a growing population moving towards a low-carbon economy, the fundamental imperative for the mining industry is to extract maximum value from every resource with minimal waste and energy. For example, the need to access resources in remote locations, reduce human exposure to hazards, and minimize waste and energy during mining operations is a common requirement for both terrestrial and planetary mining operations.

To explore, extract, process, and utilize planetary resources effectively and sustainably, we require both spin-off technologies from Earth and new innovations developed for the uniquely hazardous and extremely remote environment of space. The new small-scale, zero-waste resource collection and utilization technologies being developed for the Moon or Mars will also return benefits for terrestrial mining.

Here we present a review of major technologies being developed for space resources in an ISRU context, and how they offer promise to deliver additional value for Earth resources production chains.