IAF SPACE EXPLORATION SYMPOSIUM (A3)
Interactive Presentations - IAF SPACE EXPLORATION SYMPOSIUM (IP)

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EXPLORING THE NEXUS OF ASTEROID MINING AND PRE-BIOTIC SIGNATURES:TOWARD SUSTAINABLE EXTRA-TERRESTRIAL HABITATS

Abstract

The asteroid belt situated between Mars and Jupiter preserves remnants from the early solar system, providing a unique opportunity to gain insights into its formation over 4.6 billion years ago. Within this region, ancient asteroids may harbor pre-biotic signatures such as amino acids, organic compounds, and water ice, offering valuable clues about the conditions preceding the emergence of life. This research proposes a comprehensive exploration of the Asteroid belt, integrating prebiotic signatures exploration, asteroid mining, and human habitation, whilst identifying technical, logistical challenges and proposing solutions through conceptual mission designs. The exploration would contain multiple missions spread across three phases. The research will include the design of an optimal prospecting mission, proposed methods for asteroid identification for mining along with a concept for asteroid-based habitat. In the first phase, a spacecraft will be dispatched to study and analyse various asteroid types, specifically focusing on P-type and D-type asteroids, while examining C, M, and S-types. During this phase, the primary goal is to investigate the presence of prebiotic elements such as amino acids, protein bases, and water ice, along with minerals such as platinum, Titanium, Iron, and Copper. Based on data gathered in the phase 1 missions, the second phase involves sampling through mining asteroids, with a focus on possible solutions for bringing these samples back to the nearest inhabited celestial body. For Phase 1 and Phase 2, the methodology would involve detailed mission design for one spacecraft each, surpassing the Mission Concept Review stage. The third phase delves into establishing a manned habitat amongst asteroids

with the information and resources gathered from previous phases. For Phase 3, the suitability of a habitat on-surface and inside the asteroid will be investigated and a concept design will be proposed. By utilising existing literature, state-of-the-art reports, and systems engineering analysis tools, such as trade-off analysis, the study will determine optimum designs for structure, propulsion, power, communication, and payloads for both spacecraft and habitat. In summary, this research envisions asteroids as platforms for scientific research, manufacturing, human settlement, and stepping stones to exploration beyond the asteroid belt.