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ISRU IN MERIDIANI PLANUM: A RESOURCE ASSESSMENT FOR THE WATER AND IRON PRODUCTION ON MARS

Abstract

Human exploration on Mars is the most challenging goal to achieve during this century. Commissioning the first human settlements requires the support of space resources operations as many planetary materials need to be extracted and used in-situ, i.e., water, oxygen, and iron alloys, for a wide range of applications, allowing a sustainable human presence. The Mars Global Surveyor and the Opportunity Rover data gave compelling evidence of layers of hydrated minerals and hematite "blueberries" in enriched grades (up to 25 wt%) at the Meridiani Planum region, around accessible zones. If the human-technology development successfully achieves water production from sulfates and iron from hematite, Meridiani Planum would be one of the primary candidates for the first human cities on Mars due to accessibility of the raw matter, temperature variation, and sunlight availability in the equator zone.

Before sending any new prospecting missions, we must explore architecture designs for mineral processing and design future experiments to apply in-situ, to evaluate the operational requirements. This research elaborates and expands the current information of the genesis of the deposit, explaining the formation process of the sulfates and hematite satisfactorily. The mining unit location candidate is selected using the GIS tools. This research reviews the features of sulfates and hematite, density, grade, possible mineralogic forms, and water and iron available. The database is obtained from the information gathered by the Opportunity Rover and its instruments: Alpha Particle X-Ray Spectrometer (APXS) and the Miniature Thermal Emission Spectrometer (Mini-TES). All the data was processed and classified using statistical software.

Finally, the authors evaluated the electrostatic concentration of the sulfates and the classification of hematite grains based on the ore behavior in different scenarios. Additional calculations were performed to assess the sulfates dehydration and hematite reduction process, calculating the temperature, entropy, and required Gibbs energy. The authors used metallurgical modeling and simulation tools in software applied in the mining industry for all the process design sections. The outcomes are presented in a metallurgical architecture, including metallurgical recovery, mineral mass, and power requirements.