A geometallurgy approach of the exploration of lunar ilmenite

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Space mining will be the greatest challenge of the current century. Many researchers have developed metallurgical processes to concentrate lunar ilmenite and produce oxygen on the Moon. This study reviews the geological data of the regolith and breccias sample brought by Apollo 11 to verify ore features that affect the metallurgical behavior. This approach is known as geometallurgy and intends to combine geology with metallurgical engineering to solve the lunar context's mining problems. The authors review the characteristics of the "degree of liberation" and "chemical composition" of ilmenite on Mare Tranquillitatis and their impact on concentration under the geometallurgy using mineralogical calculates metallurgical balances, thermodynamic tools from HSC Chemistry software, and statistical analysis for lunar breccias with software Minitab.

Mare Tranquillitatis as an excellent soil to be processed since it is a fine grain size material. However, the fine Ilmenite is hard to concentrate from the regolith up to an acceptable grade because other minerals lock its particles. The degree of liberation is intrinsic to the regolith; therefore, although it will test many processing techniques, the results will be directly influenced by the degree of liberation, and it would not be feasible to apply current grinding technologies to increase it. Regolith particles are fine, but most ilmenite appears encapsulated. There are no data that describe the entire particle size distribution, but the size ranges analyzed by direct and indirect methods show less than 40% free ilmenite. This information should lead us to evaluate other ilmenite sources, such as the rocks and breccias mixed with the regolith, which have a higher content of free ilmenite (greater than 75%)[1]. In the same case, only ilmenite with low magnesium should be processed with chemical composition to increase performance. The lunar breccia samples show that the magnesium oxide content is highly variable in the ilmenite with a statistical non-normal distribution of the MgO content. According to statistical and thermodynamic calculations, the presence of this oxide in ilmenite is detrimental to the process since it dilutes the iron content and reduces the process's efficiency. Future mining operations must identify high MgO and low MgO ilmenite as a correction factor in the economic evaluation of the deposit. Chemically, the Mare Tranquillitatis is a high deposit of ilmenite to mine. Instead, considering geometallurgy, the ilmenite in the deposit must be classified according to their degree of liberation (free or mixed) and according to its magnesium oxide content. This knowledge will assist in selecting the right location in the deposit to mine, the right size range to process, and an accurate metallurgical architecture to maximize the operative results and, therefore, the profitability[2] .

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