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A TECHNOLOGICAL TRADE-OFF ANALYSIS FOR ASTEROIDS MINING THROUGH CHEMICAL PROCESSES

Abstract

Evaluating the technological and economical feasibility of asteroids mining is a very complex topic and still open to debate. The presence of such a big variety of minerals among asteroids showed the need of associating a proper chemical extraction process to a potential resource in a qualitative way.
A trade-off has been developed by following certain criteria, allowing the selection of some standing-out processes and consequently their in-depht study.
As a starting point, a spectral distribution of both NEAs and MBAs populations has been developed, in order to highlight which types are mainly present, as the C-type asteroids in the outer Main Belt or the S-type ones near the Earth.
In relation to these results, the outcoming spectral classes are analized from a mineralogical point of view, to better understand which kind of resources (e.g. metals, semiconductors) could be obtainable from the minerals themselves. By taking into account resources' cost, availability on the Earth and technological applications, some materials turn out to be more interesting with respect to others, as the Silicon and the Iron on the S-type asteroids or the Water on the C-type ones.
Therefore, by the means of a correlation procedure between high TRL terrestrial chemical processes and the selected minerals (e.g. Ferrosilite, Fayalite), unexpected but stimulating outcomes arise.
For instance, the chance of exploiting *in situ* reaction products in order to obtain the required reactants would allow the self-sustainability of the process itself. The foremost result is a non-negligible reduced mass at launch.
An example is the reduction of Hematite with Hydrogen, that produces both Iron and Water. An option could be producing the Hydrogen needed from the Water by electrolysis. Such a kind of *closed loop process* could reduce the cost of the whole mining activity and make it more self-sufficient.
Furthermore, the number of steps involved in the extraction of a certain chemical element or compound is a key-point in the trade-off.
Collecting all the outcomes, a n-dimensional graph has been drawn up in order to compare all the possible combinations on the basis of n-criteria, as the time required to complete the extraction, its efficiency, the amount of reactants needed, the TRL.
The most convenient mining processes, resulting from the latter, are developed in detail to prove their technological and economical feasibility.