

SPACE EXPLORATION SYMPOSIUM (A3)  
Solar System Exploration (5)

Author: Mr. Nima Gharib  
McGill University, Canada, nima.gharib@mail.mcgill.ca

Mr. Pejman Nekoovaght Motlagh  
McGill University, Canada, pejman.nekoovaght@mail.mcgill.ca  
Prof. Ferri Hassani  
McGill University, Canada, ferri.hassani@mcgill.ca

## MICROWAVE ASSISTED ROCK BREAKAGE FOR SPACE MINING

**Abstract**

With the new advancements in space technology and also involvement of private sectors in space programs, space mining became an attractive subject either in In-Situ Resource Utilization (ISRU) on the moon or mineral extraction from an asteroid. One can imagine that excavation and breakage technique that will be used will mainly be affected by the terrestrial methods which has been tested, tried and proved reliable. Drilling rocks is the first stage in order to extract the resources. It mainly relies on the mass of the drill and the reactive force that comes from the gravity. On the moon or an asteroid, where the gravitational force is one sixth or negligible, the drilling performance would not be equivalent to that on the earth.

In this study, employment of microwave as a mean to reduce strength of the rocks before drilling is investigated. A magnetron can be installed on the drill and emit microwaves on the rock surface. Microwave penetrates into the rock and creates macro/micro fractures on the surface of the rocks due to thermal expansion ratio within grains, consequently easing the breakage process. Tests were performed on basalt, a common hard rock sample, when exposed to 3 kW electromagnetic waves at 2.54 GHz in a 60 by 60 by 60 cm confined oven. Temperature was measured at different depth of the rock as its distance varied from the wave-guide. Numerical modelling was also carried on to study the power dissipation inside the load and electric field distribution inside the oven.

Experimental experiences show, when exposed to microwaves, the micro-cracks density inside the rock increases which will result in less breakage energy requirement during drilling or crushing. Employing Microwave assisted drilling in space drilling or crushing applications may improve the drilling equipment performance; even though the gravitational forces are very low. Furthermore, microwave assisting drills will weight lighter compare to a conventional drilling rig. This reduces significantly the transportation costs the outer space.