

Challenges of Designing a Tunnel Boring Machine (TBM) for Development of Underground Structures on the Moon

Jamal Rostami¹, Chris Dreyer², Brad Blair³ and Ruben Duhme³

¹ Earth Mechanics Institute (EMI), Dept. of Mining Engineering, Colorado School of Mines, Golden, CO, USA. rostami@mines.edu

² Center for Space Resources (CSR), Dept. of Mechanical Engineering, Colorado School of Mines, cdreyer@mines.edu

³ Planetary Resource Engineering LLC, Canterbury, NH USA, planetminer@gmail.com

³ Herrenknecht Asia Headquarters, Singapore, duhme.ruben@herrenknecht.com

ABSTRACT

Any deep space mission requires developing a base on the moon to be the staging area for long term missions. Current and future goals for human activities on the Moon could be achieved by the creation of underground spaces. Human habitation on the Moon will require shielding from radiation, protection from micrometeorites, structure to maintain atmospheric pressure in the living quarters, and a means to survive the cold lunar night. Locating a human habitat several meters below the lunar surface by tunnelling would provide greater protection from hazards than a surface habitat covered in regolith while also providing a more stable thermal environment than the surface. A Lunar Tunnel Boring Machines (LTBM) would be designed for the lunar environment and boring in lunar material. An advantage of a LTBM over lunar surface excavation for Cut and Cover structures (C&C) is that the cutting forces needed to penetrate the ground is provided by wall grippers as opposed to surface excavation that relies on the weight of the machine, which is only 1/6th the weight on earth. A LTBM could also be used to access rilles (lava tubes) at a distance from collapsed sections or skylights, thus reducing the hazard of rock fall when exploring these regions. LTBM could also be adapted for the frozen regolith in the permanently shadowed craters at the lunar poles, which may be an attractive option for access to lunar ice resources. This paper will discuss lunar base design concepts and requirements and possibility of application of a LTBM. Design constraints of a LTBM, such as cutter design, mass, and power, as well as potential solutions to address such constraints will be presented.

Key Words: Space mining and construction, Lunar Tunnel Boring