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PHOBOS AND MARS ORBIT AS A BASE FOR MAIN BELT ASTEROID MINING

Abstract

The number and total mass of high value near-Earth asteroids (NEAs) are limited. If space mining become profitable then at some point it will need to move on to the far greater resources of the Main Belt asteroids (MBAs). Most MBAs are energetically too hard to reach with present technology from low Earth orbit (delta-v ¿ 7 km/s, Taylor et al. 2018). An alternative is to use Mars Orbit as a base from which to conduct MBA prospecting and mining.

We have investigated whether Mars orbit, both a low orbit at 100 km and Phobos at 9000 km, are usefully more energetically favorable locations to dispatch missions to MBAs. We find that they are, with Phobos having a small advantage. Around 10,000 known MBAs have delta-v < 4 km/s and some 100,000 have delta-v < 5 km/s. (For comparison Benner lists 19 and 909 NEAs with the same limits respectively; the 2 mt OSIRIS-REx mission target Bennu has 5.1 km/s.) Unsurprisingly the accessible MBAs have low inclinations ($i < 5$ deg) and small semi-major axes ($2.0 < a < 2.5$ AU). Known MBAs are much larger than NEAs, so the total mineable mass that is accessible is far larger than among the NEAs.

As a result a growing economy that utilizes space resources will likely find Mars orbit convenient. An Earth and cis-lunar economy may well then invest heavily in Mars orbit facilities. The radiation protection and stable platform afforded by Phobos would make it a natural first choice. Once Mars orbit has a profitable economy, with high value transshipments, the Martian surface may also become valuable for reasons beyond pure settlement. This value may then stimulate settlement.

The delta-v values and the code for calculating delta-v from any solar system planet to rendezvous with a small body will be made publicly available.

Taylor, A., McDowell, J.C., Elvis, M., 2018, Acta Astronautica, 146, 73.