

NO RISK, NO REWARD - ASTROFORGE AND THE FIRST COMMERCIAL DEEP-SPACE MISSION

M. Gailch¹ and J. Acain¹, ¹AstroForge Inc. 15261 Connector Ln. Huntington Beach, CA, 92649.

Introduction: AstroForge is a private company located in Huntington Beach, CA, whose mission is to make critical resources accessible on Earth by extracting platinum group metals from asteroids. The company is taking advantage of the recent advancements in space access and technology, which have seen lowering launch costs [1] and a rise in the number of small satellite vehicle and component manufacturers [2] [3]. In the last decade alone, the launch costs to access space has seen an 88% drop. [4] The small satellite market has expanded 70% and is valued at \$296B since 2010. [5]. Combined with growth in venture and equity investments in the space sector [6], these enabling factors have allowed AstroForge to demonstrate its technology roadmap faster and for a much lower cost having launched its first refinery demonstration mission to low-Earth orbit in April 2023 and preparing to launch the first commercial deep space mission in Q4 2023 in its first 15 months as a company.

Mission One: On April 15th, 2023, AstroForge sent its first mission to low-earth orbit on the Transporter-7 mission via a Space X Falcon-9 launch vehicle. The satellite, Brokkr-1, is a 6U cubesat with a mission to demonstrate the refinery technology developed by the company.

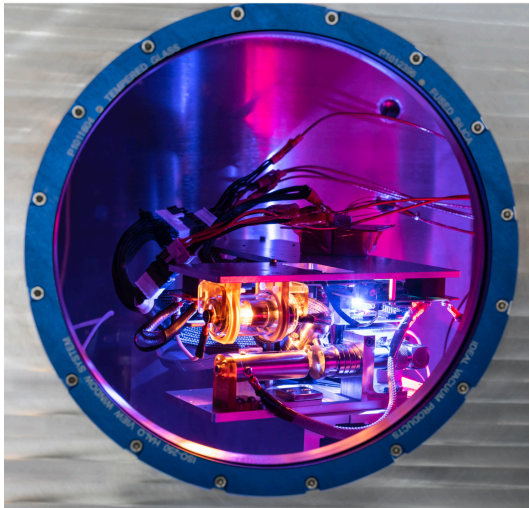


Figure 1: Refinery in TVAC testing

The refinery will extract platinum from an asteroid-like sample and collect it on a collection plate. An XRF spectrometer is on-board to detect the elements on that collection plate since the vehicle will not be re-entering to return the sample. The refinery has been

demonstrated on the ground in space like environments, including the thermal ranges and high vacuum. The main purpose of the flight is to test the refinery in a microgravity environment to anchor our analysis for the production refinery. The results of the mission will be released in a subsequent paper once testing has been completed and the results have been analyzed.

Mission Two: The Brokkr-2 vehicle is a 100kg spacecraft whose mission objectives will be to take high resolution images of our target asteroid to validate the surface terrain to prospect future refining sites and confirm the survivability and lifetime of the vehicle and its components for two years, the length of time we expect the full refining mission to take.

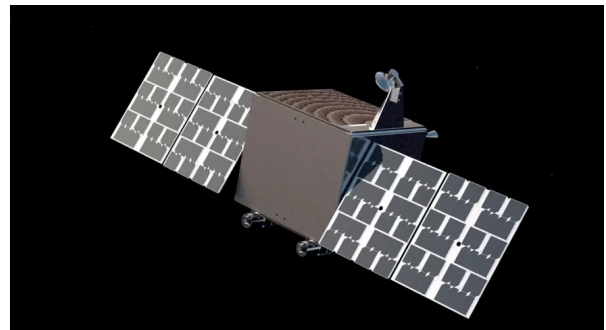


Figure 2: Brokkr-2 vehicle

Commercial lunar Payload Services: NASA has committed to provide over 2.6B [7] in funding for missions going to the moon. This unlocked a capability never accessible before, commercially available, low-cost, high-energy lunar rideshares. This enabling access minimizes the propellant we launch with and allows us to get to the asteroid on a smaller vehicle platform. The company has signed a contract with Intuitive Machines to launch the Brokkr-2 vehicle to a Trans-lunar Injection (TLI) orbit for a cost in-line with the current LEO ride-share missions.

Satellite Bus: Because of the increase in bus and component manufacturers, AstroForge elected to purchase the vehicle for this demonstration. This method allowed the company to procure more vehicles and iterate the design faster. The development and build costs were offset by supporting the manufacturer with our internal team to bring the cost down and bring the delivery time to just under a year.

The selected bus contains avionics and power systems built and designed by Orbital Astronautics and a

Dawn Aerospace propulsion system capable of delivering 1.1 km/s delta-V. The main payload is two +20MP imagers developed internally as we wanted a higher resolution camera sensor.

Asteroid Data: AstroForge co-founders were co-authors on a recent paper published that used the meteoritic database and available asteroid spectral and albedo data available publically. The results of the research reinforced the existence of platinum group metals in higher concentrations on near-earth asteroids [8]. This research was instrumental in the selection process as it aggregated the previous research done with and data collected since. The company has since selected 31 target asteroids with accessibility and asteroid type as its main factors in the decision.

Mission Three and Beyond: Development is already underway for the third and fourth demonstration missions.

The third mission will travel to the same asteroid as mission two. Instead of just doing a flyby, the vehicle will slow down and travel alongside the body, and using the on-board gamma-ray spectrometer, it will collect data about the asteroid over a period of 2 months. Once the gamma-ray data is collected, the vehicle will then dock with the asteroid. An XRF system will then be used to take a direct sample of the surface of the asteroid, confirming the presence of each PGM.

The fourth mission will be the first attempt at refining the asteroid on-site. We will again dock with the asteroid, and spend a month refining the surface of the asteroid. The material will then be returned to Earth where it will be sold.

References:

[1] Jones H. W. (2018), *ICES, 2018-81*, 48th [2] NASA AMES (2021), *NASA SOA*, C2 [3] BIS Research et al. (2017) *Global Small Satellite Market*, Annex C [4] Roberts T. G. (2022) *Boost Phase Missile Defense*, 36-44, A1 [5] Bastian L. A. (2022) *AreaDevelopment Article*, Q3-2022 [6] Bland R. et al. (2022) *McKinsey Article*, 11-16-2022 [7] Warner C. et al. (2018) *NASA PR*, PR 18-105 [8] Cannon K. M., Gialich M., Acain J. (2023) *Planet. & Space Sci*, 105608, V25

Additional Information: If you have any questions or would like more information, please contact Matthew Gialich (CEO) at: matt@astroforge.io or Jose Acain (CTO) at jose@astroforge.io.