Project Yukon

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Abstract

Project Yukon is a 10 year mission to colonize the dwarf planet Ceres with autonomous robots and facilities to begin mining asteroids in the asteroid belt. There are untold riches estimated in the hundreds of quintillions of dollars ripe for the picking. NASA will conduct the mission is collaboration with commercial partners, such as Deep Space Industries and Planetary Resources, who are interested in exploiting this untouched resource. Starting in 2030, it will piggyback off the success of Project Artemis, NASA’s attempt to colonize the moon, and send rockets to Ceres with the first robots to begin construction of Hermes Station. It will require 5-10 years to transport all the robots, machinery, and equipment to Ceres and begin operating at maximum efficiency. Once Hermes Station is operational, robots can begin branching off to asteroids near Ceres and mine them for their rich deposits. These asteroids are believed to be rich in platinum group metals, gold, and various other precious metals. The influx of these valuable materials will lower the costs of commercial goods that require such metals. This will stimulate commercial growth and harken a new era of space exploration by private companies looking to exploit the solar system’s vast resources. While the initial cost to establish Hermes Station is remarkably high to the point of driving away potential investors, the long-term return on investment is astronomical.

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NASA has estimated that there is $700 quintillion ($700,000,000,000,000,000,000) worth of precious metals (namely platinum), water, and other valuable resources flying around our sun in the 1 million or so asteroids that orbit in the asteroid belt between Mars and Jupiter (Desjardins, 2016). By comparison, Earth’s total annual raw material production totals up to $660 billion (Desjardins, 2016). This prospect shows signs of being the next great gold rush. Project Artemis, NASA’s attempt to colonize the moon, hopes to put 2 astronauts on the moon by 2024 and establish a sustainable lunar base by 2028, NASA is given a unique opportunity to take advantage of the moon’s low gravitational pull to launch rockets with less fuel, more carrying capacity, and at a much cheaper rate per rocket (Dunbar, 2019). While NASA’s main objective, once this lunar base is established, is to begin sending rockets to Mars, Project Yukon’s call lies beyond Mars: the dwarf planet Ceres. Ceres is the largest object in the asteroid belt. It makes up 25% of the asteroid belt’s mass (Overview: Ceres, 2019). Despite this, Ceres is 2.4x smaller than Pluto and 13.5% smaller than Earth (Overview: Ceres, 2019). Ceres presents NASA with the opportunity to establish a base to act as a hub for asteroid mining activities in the asteroid belt: Hermes Station. The potential return on investment from these mining expeditions could be massive; the amount of rare metals that are estimated to exist in these asteroids could make these companies trillions upon trillions of dollars.

# Mission Subject

Project Yukon will be a joint operation between NASA and commercial partners interested in exploring this new prospect. Ceres is an attractive area for Hermes Station. Its large, stable mass will allow NASA to build large processing and refining plants and access the deep water reserves on the planet to fuel the rockets that travel to and from Hermes Station to export the refined resources. Its proximity to Mars also allows it to be a source of metals and water for future Martian colonies.

# Mission Objective

Project Yukon hopes to open the door to the asteroid mining industry. By opening the door to asteroid mining, NASA hopes to gain interest and support from commercial partners that will allow long-term operations to continue into the foreseeable future. Hermes Station is just the beginning; new outposts can be established throughout the asteroid belt and even more asteroids can be harvested for their rich deposits. The long-term return can stimulate massive growth and prosperity for the commercial sector and the consumers. NASA has the know-how, technology, and majority of the funding to help the interested companies that want to pioneer this new industry. Once investors see the initial returns, they will be more inclined to invest themselves and drive the price of expeditions down. The metals found can drastically reduce their price and allow them to be used more widely throughout the manufacturing world. The water they find can sustain future Martian colonies and produce enough rocket fuel for rockets to explore the vast reaches of the cosmos. All the industry needs to do is get over the initial difficulties associated with start-up ventures before the massive returns start flowing in.

# Mission Type

Project Yukon will be a long term colonization mission. Based primarily off the moon, Project Yukon will send multiple rockets over the course of 10 years to build Hermes Station on Ceres. Once established Hermes Station will be in operation for the foreseeable future as a major hub for asteroid belt activities and resource production. While humans themselves will not likely visit Ceres for anything more than a few hours, if at all, robots will be there to colonize Ceres on their behalf.

# Mission Users

There are already companies that seek to exploit this newfound industry; Deep Space Industries and Planetary Resources are investing millions of dollars to start mining near-Earth asteroids before moving into the asteroid belt when the technology and money become available. NASA will have the technology and money necessary to help these start-ups reach the asteroid belt and begin reaping the profit. The returns these companies and NASA could make could pay off the initial expenditures multiple times over and attract dozens of new investors and companies to the asteroid belt.

The influx of rare metals, such as platinum group metals, gold, and nickel, could drastically lower the cost to produce consumer goods that use these rare metals. Platinum group metals are exceptionally rare but highly useful. They are very stable, have high melting points, and are resistant to corrosion (Bell, 2018). They are used primarily as catalysts for chemical reactions but are also used in the medical field, as alloy strengtheners, and as chemical additives (Bell, 2016). “According to the International Platinum Group Metals Association (IPA), one-quarter of all goods manufactured either contain a PGM or had a PGM play a key role in its production” (Bell, 2016). Gold also has obvious value. Due to its resistance to corrosion, high conductivity, malleability, and luster, it is used in jewelry, computer parts, and many other fields (The Many Uses of Gold, n.d). Its rarity and value mean that anyone who can mine it from the asteroid belt is guaranteed wealth. It is estimated the there is more platinum in one asteroid than has ever been mined on Earth (Desjardins, 2016). Consumers would feel the economic shifts as more precious metals are introduced to the world economy.

The water present in Ceres and the trace amounts found in asteroids can and will be harvested to help sustain human populations, especially when humans colonize Mars and the moon, and be turned into rocket fuel. If Ceres is, in fact, 25% water, it contains more water than all of Earth (Overview: Ceres, 2019). Producing and exporting this water and fuel will be a very profitable venture for the investors and mining companies that dare to go where nobody has gone before.

NASA can benefit financially from this mission as well. While NASA doesn’t generally take financial benefit from its missions, the government can still tax the goods imported from Ceres and return some of the benefits to NASA and the American people. Depending on mining output, the government could collect millions of dollars in taxes from Cerean mining entities exporting their goods to Earth.

# Mission Duration

NASA’s Project Artemis is scheduled to be operational by 2028. Our first rockets to make the journey to Ceres will launch in 2030. The initial base will be constructed by the first few robots that are brought to Ceres. They will build the larger machinery that is shipped in parts. These machines will begin mining the regolith on ceres to create a concrete-like substance. This is what the refineries and processing facilities will be built out of. By using locally sourced material, we drastically reduce the cost that could come with shipping materials from Earth as well as free up more space for necessary machinery. Overtime, as more rockets with more mining robots, maintenance robots, and refining machinery arrive, the base will slowly increase productivity. Later rockets will bring robots and vehicles capable of flying off Ceres to nearby asteroids to begin mining for precious metals. We expect this whole process to take approximately 5-10 years depending on funding and machinery development. The base should reach 100% output by 2040.

# Mission Elements

To avoid complications, NASA will use autonomous robots to conduct the mining operations and oversee the production, refinement, and shipment of the raw materials. This way, there is no need for the added expenditures necessary to keep a human crew alive, like food, permanent shelter, oxygen, water, etc. Humans might not step foot on Ceres until decades after the first robot rolls out of its lander. Such technology is readily available; mining companies are turning towards autonomous equipment to increase productivity, efficiency, and lower costs here on Earth.

The base on Ceres will be a two-part operation: mining and production. First, the robots will spread out to various asteroids in the area and begin mining them for metal-rich ore. Once they are full, they will return to the base on Ceres or other, smaller bases that are created in the future and deposit all the ore. This ore will then be processed and refined into the pure resources that can then be transported back to Earth or other future colonies on the moon, Mars, or otherwise. Humans will be able to monitor and control the base from Earth, albeit with the 30-minute delay that it takes for the signals to travel the distance between the two. During the time directly after the base becomes operational, all exports will be sent to the moon base. This way, the shuttle rockets will never have to use more fuel to escape Earth’s gravitational pull.

Ceres takes 9 hours to make one rotation about its axis, so sunlight would be limited to 4.5 hours (Overview: Ceres, 2019). Thus, solar panels would have to be numerous in quantity to power the facilities and robots. Hydrogen fuel cells would store any unused energy for periods of darkness. Ceres is thought to have large water reserves in its mantle, up to 25% of Ceres’ composition (Overview: Ceres, 2019). This will allow the refineries to create hydrogen and oxygen for rocket fuel. This rocket fuel will allow mining robots to refuel when they return to Ceres instead of having to ship fuel from Earth. So much water exists that one of Ceres’ main exports could be rocket fuel and water. This water and fuel could be sent to Martian colonies where water doesn’t exist naturally, except in small quantities of ice at the poles.

# Mission Constraints

The elephant in the room is the cost. NASA is currently in the process of completing OSIRIS-Rex, an effort to recover a 70-ounce sample from a crater on the asteroid Bennu. This will cost approximately $1 billion (Desjardins, 2016). Theoretically, if the 70-ounce sample was pure platinum, the current price of the sample would be $59,336.20 (Platinum PRICE Today, n.d). The sample might contain traces of platinum, but there is an infinitesimally small chance of it being even half platinum, let alone pure platinum. The short-term financial prospect of investing trillions of dollars for such a small return would turn away most investors. Not many are willing to look toward the long-term returns that will come ten to twenty years from now. This is why NASA is partnering with the private sector companies that are interested in piggybacking off NASA to start exploring the asteroid belt. By having them invest in the mission, the cost is more evenly distributed and, thus, the liability is less impactful to one entity. It will still be a major investment, but now NASA doesn’t have to rely as heavily on the tax dollars and the government.

The other major setback is distance. Ceres is a year’s journey away from Earth with current technology. This means that if anything goes wrong, it will take astronauts at least a year to get there, and that is without preparing the rocket, astronauts, and funding for the journey. Therefore, NASA is opting for full autonomy and self-sufficiency. This will drastically reduce costs and risks. If something does go wrong, maintenance robots can be sent to go assess and repair the machinery.

Project Yukon may seem like a daunting task on paper. The cost is a major liability and the sheer scale of the operation is unheard of since John F. Kennedy said that the US was going to put a man on the moon. Despite these limitations, NASA is completely dedicated to Project Yukon. Hermes Station will be a gateway to the asteroid belt and outer solar system. Once established, Hermes Station will be a beacon for investors and commercial entities to come and stake their claim in new frontier. The potential return for NASA and these companies, let alone the private sector and science as a whole will be astronomical. By 2040, Hermes Station could be churning out trillions of dollars in resources to be used to improve life on Earth, sustain future colonies and Mars and beyond, and opening the solar system to more pioneers. Human exploration is an inevitable call of nature. It is only a matter of time before we reach for the stars. Project Yukon is the gateway to the future of humanity.

References

Atkinson, N. (2015, December 24). What Are Asteroids Made Of? Retrieved from <https://www.universetoday.com/37425/what-are-asteroids-made-of/>

Bell, T. (2018, December 10). What are Platinum Group Metals (PGMs)? Retrieved from https://www.thebalance.com/platinum-group-metals-pgms-2340166

Desjardins, J. (2016, November 3). There's big money to be made in asteroid mining. Retrieved from https://www.businessinsider.com/the-value-of-asteroid-mining-2016-11

Dunbar, B. (2019, July 23). What is Artemis? Retrieved from https://www.nasa.gov/what-is-artemis

Overview: Ceres. (2019, January 28). Retrieved from https://solarsystem.nasa.gov/planets/dwarf-planets/ceres/overview/

Platinum PRICE Today | Platinum Spot Price Chart | Live Price of Platinum per Ounce | Markets Insider. (n.d.). Retrieved from https://markets.businessinsider.com/commodities/platinum-price

The Many Uses of Gold. (n.d.). Retrieved from https://geology.com/minerals/gold/uses-of-gold.shtml