Project Ares

Gavin J. Ruby

Virginia Aerospace Science and Technology Scholars

Mission Scope

**Need-**

Project Ares will be the first program to establish a permanent human presence on Mars. It will provide a gateway for further exploration and colonization of Mars and send crucial information and data back to Earth, giving NASA a better understanding of Mars’ climate, environment, and history.  **Goal-**

To successfully establish a permanent base on Mars and a supply chain that will constantly cycle astronauts, supplies, and equipment, helping expand the settlement, increase the number of astronauts on Mars, and exponentially increase the amount of research and experimentation done on the planet’s resources and environment.  **Objective-**

Project Ares will establish the permanent base by sending twelve astronauts to establish Kepler Base in 2033 before cycling a new set of astronauts every two years thereafter to continue expansion and research.

**Mission Case-**

The establishment of such a base will be a cornerstone of space exploration for the next century. It will usher in a new age of space exploration that will bring in an unfathomable amount of new information and advancements. NASA is the most well-equipped space agency in the world. They have access to the brightest minds, groundbreaking technology, and world-class facilities. They are the best candidate to spearhead Project Ares.

**Operational Concept-**

An SLS Block 2 Cargo spacecraft will launch for Mars late February of 2031 and land in November of 2031 at 22.6° N, 16.5° W. It will begin constructing Kepler Base. Two years later, in April of 2033, Ares I, II, and III will launch and land at Kepler Base in late December of 2033. The second SLS Block 2 Cargo spacecraft will launch after Ares I-III and land at Kepler Base. The astronauts will perform experiments, research, and expansion efforts for 465 sols before getting back into their Orion capsules and launching back for Earth in March of 2035. At the same time, Ares IV, V, and VI will launch from Earth and begin their journey to Mars. Both crews will land in early December of 2035, thus completing the first cycle of Project Ares.

**Assumptions-**

NASA will have all the technologies necessary for the mission and the funding to launch all the spacecraft. NASA will adhere to the schedule and launch all the spacecraft on time to take advantage of the Hohmann Transfer Orbit.

**Constraints-**

The SLS program is already over budget and off schedule. The Hohmann Transfer only occurs every 26 months, so, if NASA misses, the whole program is thrown off. The sheer amount of supplies necessary to support four astronauts for eight and a half months that has to be packed into the Orion spacecraft is unprecedented and will require serious logistical and engineering work.

Project Ares

Mars has captivated humans since the beginnings of civilization. Observations of Mars’ motion were recorded by everyone from the Egyptians in the 2nd millennium BCE to the Chinese in 1045 BCE (Mars Facts: Temperature, Surface, Information, History & Definition, 2020). It got its name from the Roman god of war due to its reddish color. After humanity conquered its first great celestial challenge, the moon, it set its sights on Mars as its next great journey. Since the later part of the 20th century, scientists and authors alike have speculated as to how humanity will reach for the stars and begin expanding beyond our little, blue marble. Now, NASA is turning those dreams into a reality with Project Ares.

Project Ares is the third phase of NASA’s gradual colonization of Mars. The first phase comprised of rovers and satellites that gave NASA the information it needed to prepare to send humans to the red planet. The second was short term stays by small crews of astronauts that gave NASA a thorough understanding of the effects Mars’ climate and environment had on them and their equipment, like during their long-duration experiment a few years earlier (Ruby, 2020). Now, with phase III, Project Ares is looking to establish a permanent human presence on Mars. By establishing a permanent base, NASA is looking to expand the experimentation performed by the astronauts to give NASA a better understanding of Mars’ climate, geological processes, and potential resources that the astronauts could use for life-support, manufacturing, and expansion.

The main resource that NASA is seeking is one of the most crucial elements of supporting life: water. Due to Mars’ extremely arid climate, water is extremely rare and can only be found at the poles in the form of ice caps and small flows towards the equator (Redd, 2018). To support the growing population of astronauts and colonists, NASA must develop systems to produce a sustainable freshwater supply. The Promise Rover that was sent to Mars in 2024 found signs of water under polar ice caps and analyzed soil compositions for the potential for water (Ruby, 2020). Using this data and the data recovered by other satellites and rovers, NASA confirmed the existence of ice water beneath the surface and seasonal flows of water in certain areas nearer to the equator. If NASA can successfully harvest water, it will increase the capacity for more astronauts and allow more rapid expansion of a Mars colony.

# Base Name

NASA is naming the first permanent settlement on Mars Kepler Base after the famous 16th-century astronomer. Kepler played a key role in defining Mars as we know it today. He helped to prove and revise the heliocentric model proposed by Copernicus by studying Mars’ orbit and solving the “Mars Catastrophe” where his mentor and employer, Tycho Brahe, found Mars to be five degrees off of where it was predicted to be by his calculations (Gingerich, 2011). Using triangulation and physics, he correctly theorized that the planets were moving in elliptical orbits and created the Laws of Planetary Motion that make up the cornerstone of modern astrophysics. His work would pave the way for such geniuses as Galileo, Newton, and others to come forward with new data and theories that would cement the Copernican model as the customary choice of everyone from astrophysicists to schoolchildren. NASA thinks that it is fitting to name the base as such to honor his legacy and contributions to society’s understanding of Mars.

# Mission and System Requirements

NASA’s goal is to send twelve astronauts to Mars by the end of 2033 to establish a permanent base and begin conducting experiments to determine the quantity and quality of the water sources in the area surrounding Kepler Base within 30 sols of the touchdown of the first spacecraft. To accomplish this mission, NASA needed to design, test, and deploy a variety of new technology and equipment to ensure that the astronauts are never compromised and that they have the most effective resources to conduct their experiments on Mars.

The first challenge was getting the astronauts to Mars. NASA needed to design a new spacecraft to accommodate the astronauts and get them to Mars with the least amount of risk, most efficient schedule, and maximum cargo. In response, NASA developed the SLS rocket system and the Orion capsule. The SLS rocket the most advanced rocket in the world, and it can make the journey to Mars. In its Block 2 Cargo configuration, it will be capable of sending 31,950 cubic feet of cargo at a time to help get the necessary supplies to Mars in time for the Ares I, II, and III to arrive (Mohon, 2015a). All the Ares spacecraft will be the SLS Block 2 Crew configuration. This configuration keeps the same RS-25 engines and booster system as the Block 2 Cargo configuration, but now it has the Orion capsule to transport the astronauts. The Orion capsule is the newest spacecraft designed by NASA. It is much larger, more weight-efficient, and more powerful than the Apollo capsules of the past. It will carry the astronauts to and from Mars during their eight and a half month journey.

The next major feat was Kepler Base itself. It must be strong enough to stand up to the harsh dust storms, howling winds, radiation, and extreme temperatures of Mars, yet easy to build. There must be enough space for all twelve astronauts, their equipment, and life support systems. These are the questions that plagued engineers for years. To help find the best solutions, NASA outsourced the problem with various competitions, like the STMD Centennial Challenge to build a 3D printed habitat for deep space exploration (Mohon, 2015b). Thanks to the brilliance of the competitors, like AI SpaceFactory, Penn State, and others, these 3D printing systems are capable of being shipped to Mars on a cargo vehicle, use locally sourced materials, and assemble habitats that could give the astronauts ample shelter (Grossman, 2019). These systems can be sent to Kepler Base on the initial SLS Block 2 Cargo rocket to begin assembling the base. Once the astronauts arrive, they can begin assembling the more complex systems, like life support, and power generators.

Producing power is much harder on Mars than it is on Earth. There aren’t fossil fuels to burn, water to use for hydroelectricity, or infrastructure to use geothermal power. Wind farms could be useful, but they would have to be able to withstand the dust storms that rage across Mars constantly. Those same dust storms can cover photovoltaic panels and force astronauts to spend a large portion of their time cleaning and maintaining them. With all of this in mind, NASA turned to nuclear power with the Kilopower Project. “The Kilopower project is a near-term technology effort to develop preliminary concepts and technologies that could be used for an affordable fission nuclear power system to enable long-duration stays on planetary surfaces.” (Hall, 2017). Kilopower has developed several technologies, like the Kilopower Reactor Using Stirling Technology (KRUSTY), that are viable options for long-duration missions to other planets (Hall, 2017). By using nuclear fission, NASA could investigate more potential settlement locations that would not otherwise be chosen because they do not get enough sunlight to power a settlement that is powered by photovoltaic panels. The nuclear reactors can also provide the heat needed to maintain Kepler Base’s internal temperature during the extreme temperature swings to which Mars is prone.

To survive, the Ares spacecraft and Kepler base need constant life support systems (LSS) that can regulate their environment and keep them alive. NASA’s LSS focuses on environmental monitoring, atmosphere management, and water management (Jackson, 2016). Environmental monitoring is the process of analyzing the enclosed environment for anything that could compromise the mission, like fires, chemicals, air impurities, or others. These usually stem from any ongoing experiments or “technology demonstrations” (Jackson, 2016). NASA uses Microelectromechanical Systems (MEMS) to allow the use of compact modules to run constant analysis without adding undue weight or volume (Jackson, 2016).

Atmosphere management is the most important part of the LSS. It oversees the regulation of the air composition and air pressure. Humans emit gases that are harmful to themselves, like carbon dioxide, ammonia, acetone, and methane (Jackson, 2016). Atmosphere management systems use filters and complex chemical processes to scrub the air of these harmful gases and recycle the oxygen back into the cabin so the astronauts can breathe (Jackson, 2016). The air pressure is very important on spacecraft and in Kepler Base. Space has no atmospheric pressure, so, if exposed to the void, the pressure that humans have to combat the atmosphere on Earth would push outwards and kill the astronaut. This is overcome by pressurizing the cabin inside the spacecraft and Kepler Base, but, if the spacecraft or base develops a leak, the atmospheric pressure will gradually decrease until it kills the astronauts. This is why the atmosphere management system is the most important.

The last part of the LSS is the water management system. It is far too costly, heavy, and voluminous to carry enough water for the twelve astronauts for three years on their spacecraft. On the ISS, the water recycling system is 74% efficient (Jackson, 2016). For the long-duration missions to Mars, it needs to be even higher. As a result, NASA had to develop a system to provide enough water for all the astronauts for all three years without bringing too much to begin with. NASA is developing water recycling systems with a 98% efficiency, “reduced mass, power, and volume as compared to current technologies” (Jackson, 2016).

While this system will be able to sustain a dozen astronauts, it will not support colonies of hundreds of astronauts and hydroponics farms. NASA needs to develop ways to harvest enough water to support larger populations from Mars’ small reservoirs beneath the surface at a rapid enough pace to meet those needs daily. While NASA does not expect to achieve such proficiency at first, they are confident in their abilities to succeed in the long term. To begin the process, NASA needs to invest in autonomous mining technologies that can use sonar to detect the ice and begin mining it. This will require more power and crew members that have experience with autonomous programs and how to operate them. The same mining systems can harvest materials needed to expand manufacturing and base expansion.

One of the major steps towards becoming a self-sufficient base is being able to produce oxygen to breathe and propellant to get back to Earth. With Mars’ 95% carbon dioxide atmosphere and the oxygen recycler’s non-100% efficiency, oxygen will run out unless the astronauts can produce it themselves. NASA hopes to have the equipment up and running by the 50 sol mark and providing enough oxygen for every astronaut along with enough reserves to last 7 sols. To do this, NASA is using a scaled-up version of the recycling systems used on the ISS and Ares spacecraft. The process is called electrolysis and it decomposes water into its two elements, hydrogen and oxygen gas. This oxygen can be used with the LSS and the hydrogen can be used as a propellant for spacecraft.

# Timeline

NASA’s timeline is dictated by a phenomenon called the Hohmann Transfer Orbit. This phenomenon occurs when Earth and Mars are at a place in their orbits that would allow spacecraft to travel between the two with minimal change in velocity, or delta v (Hohmann transfer orbit diagram, n.d). By requiring less delta v, the spacecraft requires less fuel and, thus, can travel farther or on less fuel. This drastically improves the weight and available storage of the spacecraft. The Hohmann Transfer Orbit occurs between Earth and Mars every 26 months (Hohmann transfer orbit diagram, n.d).

The launch window the most coincides with NASA’s timeline is the 2031 Hohmann Transfer Orbit. Depending on weather conditions and various other factors that go into launching spacecraft, the first major launch with be during late February of 2031 (Hop, n.d). This is the launch of the SLS Block 2 Cargo spacecraft, named the Mars Cargo Resupply (MCR), that will supply the astronauts with all their supplies that cannot fit on the smaller crew spacecraft. Eight and a half months later, in early November, MCR I will land on Mars, deploy the autonomous 3D-printing systems, and await the astronauts. While it waits for the astronauts, it will begin producing the fuel necessary to get the Orion capsules back into orbit for the return journey. The astronauts’ launch window occurs in mid-April of 2035 (Hop, n.d). This is the next Hohmann Transfer Orbit Window. Because the Orion capsule only holds four astronauts at a time, NASA is using three SLS Block 2 Crew spacecraft to ferry the twelve astronauts to Mars, named Ares I, II, and III. They will take off in quick succession to take full advantage of the Hohmann Transfer Orbit. This also ensures that they will arrive at relatively similar times and can have all twelve hands on deck to help assemble Kepler Base and establish life support systems. In addition to the Ares spacecraft, the second MCR will launch for the second wave of astronauts, just as the first did.

After undergoing the same eight and a half month journey that the MCR did, the astronauts will touch down on Mars around late December of 2035. MCR II will land at Kepler Base and begin producing the fuel for Ares IV, V, and VI. The astronauts of Ares I should be able to recover MCR I and begin unloading. NASA expects that Kepler Base should be habitable within 7 sols of Ares I’s touchdown. The next milestone will be 30 sols. By this point, all Ares crews should have touched down, unloaded, moved into Kepler Base, assumed their responsibilities, and begun research and analysis efforts.

As the next Hohmann Transfer Orbit looms on the horizon, the crew will begin preparations for the long journey home; they will have to pack up the cargo that they are taking home, transfer the fuel from MCR I to Ares I, II, and III, and shut down Kepler Base until the Ares IV, V, and VI crews arrive. In late March of 2035, roughly 465 sols after they arrived, the crews of Ares I, II, and III will strap into their respective spacecraft and lift off the Martian surface. After entering the Hohmann Transfer Orbit, they will relinquish control to gravity and begin their long journey home. At the same time, back on Earth, the crews of Ares IV, V, and VI will be strapping into their own spacecraft, ready to begin their journey and carve their names into the history of human exploration and spaceflight.

Right around early December of 2035, Ares I, II, and III will deploy their parafoils and slowly float down into the ocean where they will be recovered and brought home for medical examinations, ceremonies, and parades, all in time to celebrate Christmas with their families for the first time in three years. At the same time, 140 million miles away, the Ares IV, V, and VI will be landing at Kepler Base to resume operations.

# Location

NASA has identified multiple areas of interest on Mars that would be ideal candidates for the first manned mission to Mars. Upon in-depth analysis of each prospect, NASA chose Mawrth Vallis, a channel created by extreme flooding during ancient times (Finding A Place to Land on Mars, n.d). Located at 22.6° N, 16.5° W, Mawrth is the Welsh term for ‘Mars’, and Vallis is the Latin indication of its status as a valley. It piqued NASA’s interest because of the presence of minerals and clays that only form in the presence of water (Finding A Place to Land on Mars, n.d). Imagery taken by HiRISE orbiting Mars shows various basaltic sands and hydrated minerals covering the landscape(Colorful Mawrth Vallis – NASAs Mars Exploration Program, 2019). One such mineral is jarosite. Jarosite forms in acidic, moist, and oxidizing conditions on Earth. The Opportunity also found signs of jarosite during its journey (Colorful Mawrth Vallis – NASAs Mars Exploration Program, 2019). This all points to Mawrth Vallis as a prime opportunity for the astronauts to experiment and investigate the soil for signs of water and to help scientists assemble a better timeline of Mars’ climate and geological changes.

# Constraints

With a mission of such a scale, constraints were inevitable. The first and most oppressive constraint is cost. The SLS program is 33% over budget at $8.75 billion (Howell, 2020). That number may continue to grow and further risk the possibility of there not being enough money to launch the Ares Program until a later date. NASA spends $2 billion annually to continue the development and testing of the SLS program. It’s estimated to cost $800 million for a bulk order of SLS rockets and $1.6 billion for a single rocket (Wattles, 2019). Others say that $800 million is an unrealistically low price and that it may cost as much as $2 billion along with “$20 billion to $30 billion over the next five years, on top of its standard annual budget, to fund the program” (Wattles, 2019). Some congressmen and women are critical of the program’s overspending and overrun schedule and would prefer to cut their losses now rather than continue to sink taxpayer money into a program that could be doomed to fail (Wattles, 2019). NASA needs to finish development and show that the SLS is the key to the future of space exploration to reinforce the idea that the people need to invest in the program to secure a presence on other moons and planets.

The second major constraint is timing. The SLS program was originally slated to make its maiden flight in November of 2018, yet it hasn’t left the launch pad to date. Major setbacks caused by development roadblocks, budgeting, and contractor performance have hindered the SLS program’s progress and caused prices to skyrocket. To be prepared for the 2031 launch window, NASA must perfect the SLS and secure the funding for the launches. While it is eleven years away, it will be one of the most expensive programs NASA has ever initiated, and NASA needs every penny they can scrape back. The timing issues don’t end there; the Hohmann Transfer Window only occurs once every 26 months and, if NASA misses its chance due to problems with the SLS or securing the funding, they will not be able to launch for over two years without having to redesign the mission to accommodate the new trajectory. The same applies to all stages of the program as they all occur during the Hohmann Transfer Window. For Project Ares to deliver twelve astronauts to Mars, NASA must launch three SLS spacecraft back-to-back as fast as they can get the vehicles ready and have optimal conditions. NASA has never launched spacecraft in quick succession like this and it will prove a daunting challenge. Time will also play a constant factor when NASA has to keep the astronauts alive for the duration of the mission; how much food they have, how much water they have, how much air they have, how much time do they have before the next cycle. These will be a constant thought behind the minds of mission control. Timing is the currency of survival.

# Risks

Going to Mars is no cakewalk. It’s one of the most dangerous endeavors in human history. There are dozens of potential pitfalls that could jeopardize the entire program. If a single nut or bolt is not properly fastened, it could spell disaster for the crew. NASA’s priority is the safety of the crew above all else. If mission control is not 100% certain that the spacecraft is good to go, they will not fly.

As previously mentioned, the three main factors that dictate the mission are food, water, and air. NASA must fit three and a half years’ worth of food on the spacecraft for twelve astronauts. The astronauts will establish a hydroponics farming system to produce crops to help feed the astronauts, but, as a precaution, NASA gives them enough food for the entire journey if they cannot produce a crop yield. If they run out of food or it is somehow contaminated or destroyed during the journey, the whole mission is jeopardized, and the astronauts are put in grave danger. NASA also must ensure that the food has enough nutritional value to sustain the astronauts during their long, laborious days.

Water is hard to come by on Mars and impossible to come by in space without the water recycling systems implemented in the Orion capsule. The recycling systems work to pull water out of the air and greywater and purifying it for consumption. If the machine is broken or fails, the astronauts will have approximately three days to live. They must have a constant supply of water to survive.

The last and most pressing issue is the availability of oxygen. There is no oxygen in space and only trace amounts on Mars. To provide the oxygen, NASA developed a system that takes carbon dioxide and turns it back into oxygen. The latest edition of it was designed by the ESA in 2018. It’s called the Advanced Closed Loop System (ACLS) and it can recycle 50% of the carbon dioxide back into oxygen (Pultarova, 2018). This is what NASA is using as a blueprint to design the oxygen recycler for the Orion capsule. Kepler Base will be equipped with a similar, albeit much larger, system that will regulate the oxygen inside the habitat and help keep the astronauts alive.

# Crew Qualifications and Responsibilities

Astronauts are some of the finest examples of human achievement. Most are former high ranking military officers, doctors, scientists, pilots, and academics, and for good reason. These professions lend themselves to intelligent, level-headed, driven leaders that strive to do their best every day. Not everyone can be an astronaut. The background one needs must be nothing short of exemplary. For NASA, you have to “be a U.S citizen, possess a master’s degree in a STEM field, have at least 2 years of related professional experience or at least 1,000 hours pilot-in-command time on a jet aircraft, and be able to pass the NASA long-duration flight astronaut physical” (Dunbar, 2015). This only qualifies you for consideration. To stand out in a field of eager prospects, you have one of the best resumés in the world. People come from prestigious careers, such as awarded doctors and Navy SEALs. These people are naturally talented as leaders, teammates, and pressure players. Their time in these first-class institutions sharpened their skills and made them ideal candidates to endure the extreme experience of making the journey to Mars. They will come from every walk of life and place on Earth. Gender, race, and religion do not play a role in the selection process, but age does play a factor. Living in microgravity for extended periods has an adverse effect on the human body, the biggest being muscle atrophy. Astronauts have to be in peak physical condition and continue to exercise every day while in space to try to lessen the effect, thus people that are older and that are not in the same physical condition that they were in during their younger years would be more prone to the muscle atrophy and the side effects that it brings, like weakening of the heart.

The mental strain that the astronauts will have to endure is unfathomable to most. This is the one factor that cannot be quantified. Psychologists and scientists have tried to study the effect of being trapped in a small capsule for long-durations, but it’s almost impossible to replicate the exact effect without experiencing it. The closest thing to the actual experience that has been studied was an experiment called Mars500. Performed by the Institute of Biomedical Problems of the Russian Academy of Sciences, six willing volunteers, all from military or engineering backgrounds, were locked in a capsule for 520 days and told to do maintenance and “research” to simulate the journey to and from Mars (Weir, 2018). The researchers observed varying stages of insomnia, stress, depression, and anxiety in all the test subjects (Weir, 2018). Even this test did not capture the full magnitude of the experience. The test subjects were anxious and mad because they were trapped in a small capsule on Earth. They knew that, if worst came to worst, there was fresh air and a normal life waiting for them outside. The astronauts will know the fear of being stuck in a capsule, hurtling through space at thousands of miles an hour, millions of miles from home, as they watch the only planet they ever knew grow smaller in the rearview mirror. If something goes wrong, nobody will know for half an hour after they send up the SOS. Chances are, if something goes wrong in space, the astronauts will be dead long before mission control has a chance to respond. Therefore, it is important that NASA chooses the most mentally strong people they can and further train them to be able to keep a level head in the direst of circumstances. Because there are three separate Ares spacecraft making the journey, each twelve-astronaut group will contain four roles with three people fulfilling them for each vehicle.

The commander is responsible for the mission, the crew, and the vehicle. The pilot assists the commander in operating the vehicle and deploying satellites. The mission specialist works with the commander and pilots in shuttle operations, performs spacewalks and conducts experiments. The payload specialist performs specialized duties as the mission requires. Payload specialists are people other than NASA personnel, and some are foreign nationals. (Astronaut, 2019)

The commander needs to have excellent leadership, communication, and problem-solving skills. They are responsible for maintaining control of the situation and keeping the spacecraft running smoothly. This might come from a background as a high-ranking official in either the military or other institutes. They should also have prior experience controlling jet aircraft. This will likely come from a military background. All commanders have prior spaceflight experience. The pilot’s main skill is being a skilled aviator with a background flying jet aircraft. This almost always comes with extensive military experience. They will also have to be comfortable making quick calculations to adjust the vehicle’s trajectory and determine long-term flight paths. The mission specialist is a jack of all trades. They must have skills in several areas, from conducting experiments to specialized training for the specific mission. The last position, the payload specialist, is the crewmember responsible for the mission-specific equipment and machinery. They are usually commissioned by the equipment’s contractor, manufacturer, or home country to oversee its transportation and use. In this case, they will likely be responsible for the oxygen generator, mining systems, or power systems. While the crew will mostly comprise of Americans, since NASA is running the program and has the largest astronaut training program, foreign astronauts will be accepted if they fulfill the requirements NASA outlines for each position. Project Ares is a step forward for humankind, not just the U.S.

# Conclusion

Project Ares is the first big leap towards the interplanetary society in the dreams of those authors and scientists from decades ago. The first men and women to walk on the red planet will be paving the way for the thousands upon thousands of pioneers, explorers, and scientists that will follow in their footsteps. It is imperative that NASA succeeds with Project Ares to secure a future amongst the stars and begins the second golden age of space exploration.

References

Astronaut. (2019, April 9). Retrieved from http://weusemath.org/?career=astronaut

Colorful Mawrth Vallis – NASAs Mars Exploration Program. (2019, March 4). Retrieved from https://mars.nasa.gov/resources/22328/colorful-mawrth-vallis/

Dunbar, B. (2015, April 8). Astronaut Requirements. Retrieved from https://www.nasa.gov/audience/forstudents/postsecondary/features/F\_Astronaut\_Requirements.html

Finding A Place to Land on Mars. (n.d.). Retrieved from https://mars.nasa.gov/mro/multimedia/slideshows/findingaplacetolandonmars/

Gingerich, O. (2011, September 1). The great Martian catastrophe and how Kepler fixed it. Retrieved from https://physicstoday.scitation.org/doi/10.1063/PT.3.1259

Grossman, D. (2019, May 10). NASA Crowns Winner in Mars Habitat Competition. Retrieved from https://www.popularmechanics.com/technology/infrastructure/a27432340/nasa-crowns-mars-habitat-competition-winner/

Hall, L. (2017, December 12). Kilopower. Retrieved from https://www.nasa.gov/directorates/spacetech/kilopower

Hohmann transfer orbit diagram. (n.d.). Retrieved from https://www.planetary.org/multimedia/space-images/charts/hohmann-transfer-orbit.html

Hop. (n.d.). Earth to Mars. Retrieved from http://clowder.net/hop/railroad/EMa.htm

Howell, E. (2020, March 17). Over budget, behind schedule: NASA's SLS megarocket faces congressional review. Retrieved from https://www.space.com/nasa-sls-megarocket-cost-schedule-oig-report-2020.html

In the Groove: Mawrth Vallis. (n.d.). Retrieved from https://themis.asu.edu/feature/46

Jackson, S. (2016, July 13). Life Support Systems. Retrieved from https://www.nasa.gov/content/life-support-systems

Mars Facts: Temperature, Surface, Information, History & Definition. (2020, March 6). Retrieved from https://nineplanets.org/mars/

Mohon, L. (2015a, March 16). Space Launch System (SLS) Overview. Retrieved from https://www.nasa.gov/exploration/systems/sls/overview.html

Mohon, L. (2015b, May 15). NASA's Centennial Challenges: 3-D Printed Habitat Challenge. Retrieved from https://www.nasa.gov/directorates/spacetech/centennial\_challenges/3DPHab/index.html

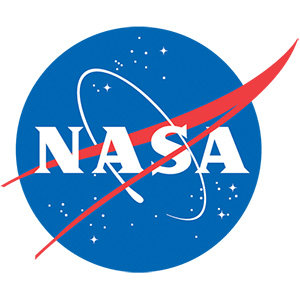
Pultarova, T. (2018, November 7). This Space Station Air Recycler Could Help Astronauts Breathe Easier on Mars. Retrieved from https://www.space.com/42362-space-station-air-recycler-for-mars-astronauts.html

Redd, N. T. (2018, August 18). Water on Mars: Exploration & Evidence. Retrieved from https://www.space.com/17048-water-on-mars.html

Ruby, G. J. (2020). *Scoping it Out Technical Report*.

Wattles, J. (2019, December 9). NASA says moon rocket could cost as much as $1.6 billion per launch. Retrieved from https://www.cnn.com/2019/12/09/tech/nasa-sls-price-cost-artemis-moon-rocket-scn/index.html

Weir, K. (2018, June). Mission to Mars. Retrieved from https://www.apa.org/monitor/2018/06/mission-mars

National Aeronautics and Space Administration

1520 H Street Northwest Washington D.C

Public Inquiries: 202-358-0001

PROJECT ARES PRESS RELEASE

Project Ares is the first great leap towards colonizing Mars. Using the SLS rocket platform and Orion spacecraft that NASA has been developing for years, NASA is planning on sending twelve brave astronauts to Mars in 2033 to establish the first Martian base, named Kepler Base, after the famous 16th-century astronomer that used Mars to discover that planets move in ellipses and to write his Laws of Planetary Motion. Kepler Base will be the permanent home to astronauts for 26 months at a time before a new rotation of astronauts comes to take up the mantle as Earth’s foremost Martian researchers. These astronauts will be researching the availability of water on Mars to support larger colonies and farming efforts using autonomous mining systems. Located in Mawrth Vallis, at 22.6° N, 16.5° W, the area is interesting to NASA because it is covered in minerals and clays that only form in the presence of water. This could lend itself to historical documentation by the astronauts to give NASA a better understanding of ancient Mars when water flowed freely across its surface. Once Kepler Base is established, the astronauts will look to expand it to accommodate more astronauts and private ventures that want to stake their own claim on the red planet. The astronauts themselves will come from every walk of life from pilot to doctor to scientist. This program is a huge step forward for humanity. NASA hopes to look back on this moment as the first step towards a golden age of space exploration unheard of since the Apollo Program.