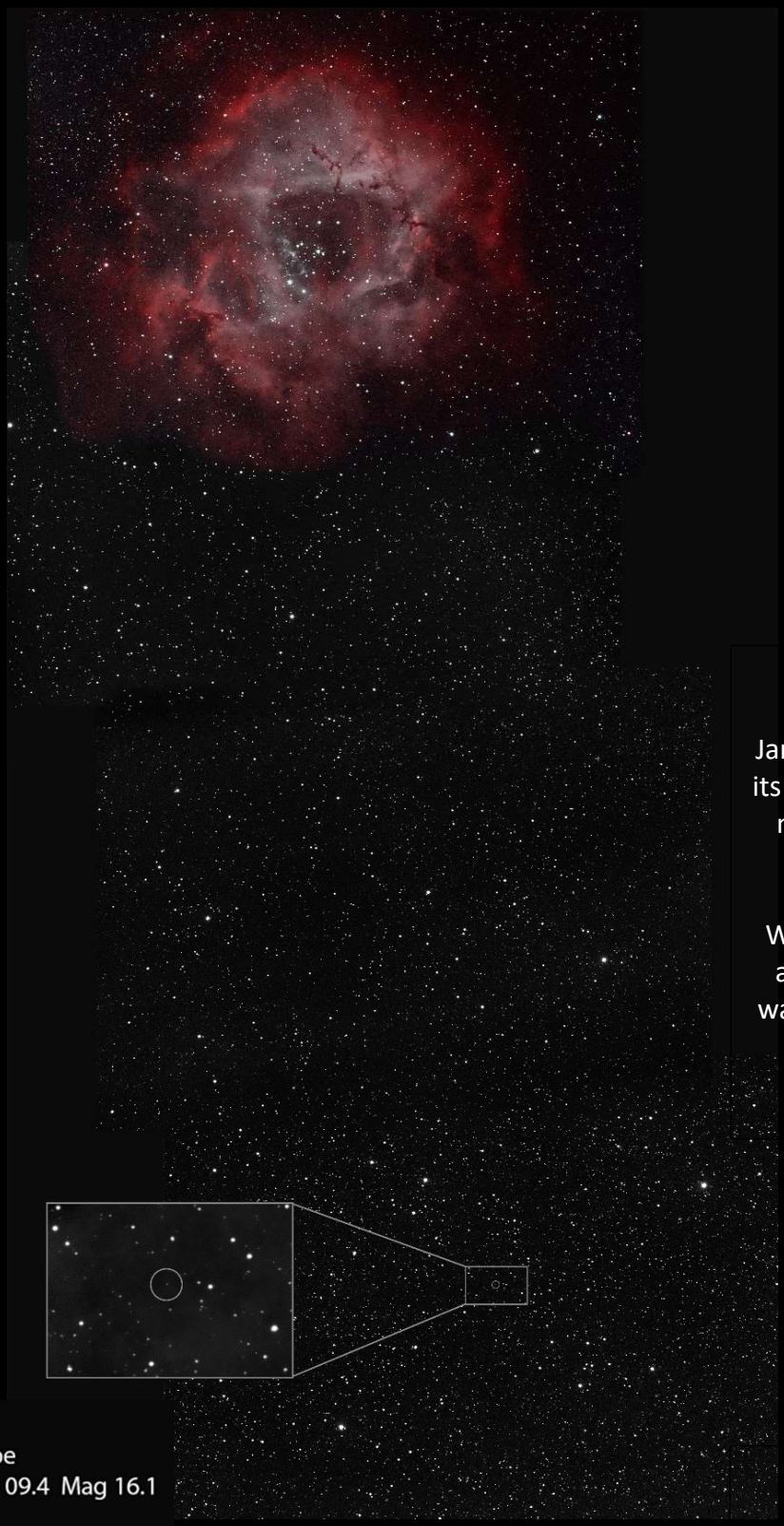
Galactic Observer

John J. McCarthy Observatory

Volume 15, No. 2

February 2022



James Webb Space Telescope captured on January 8/9 as it traveled to its final destination almost 1 million miles (1.5 million km) from Earth

Webb distance from Earth at time of image capture was about 660,000 miles or 1.1 million km

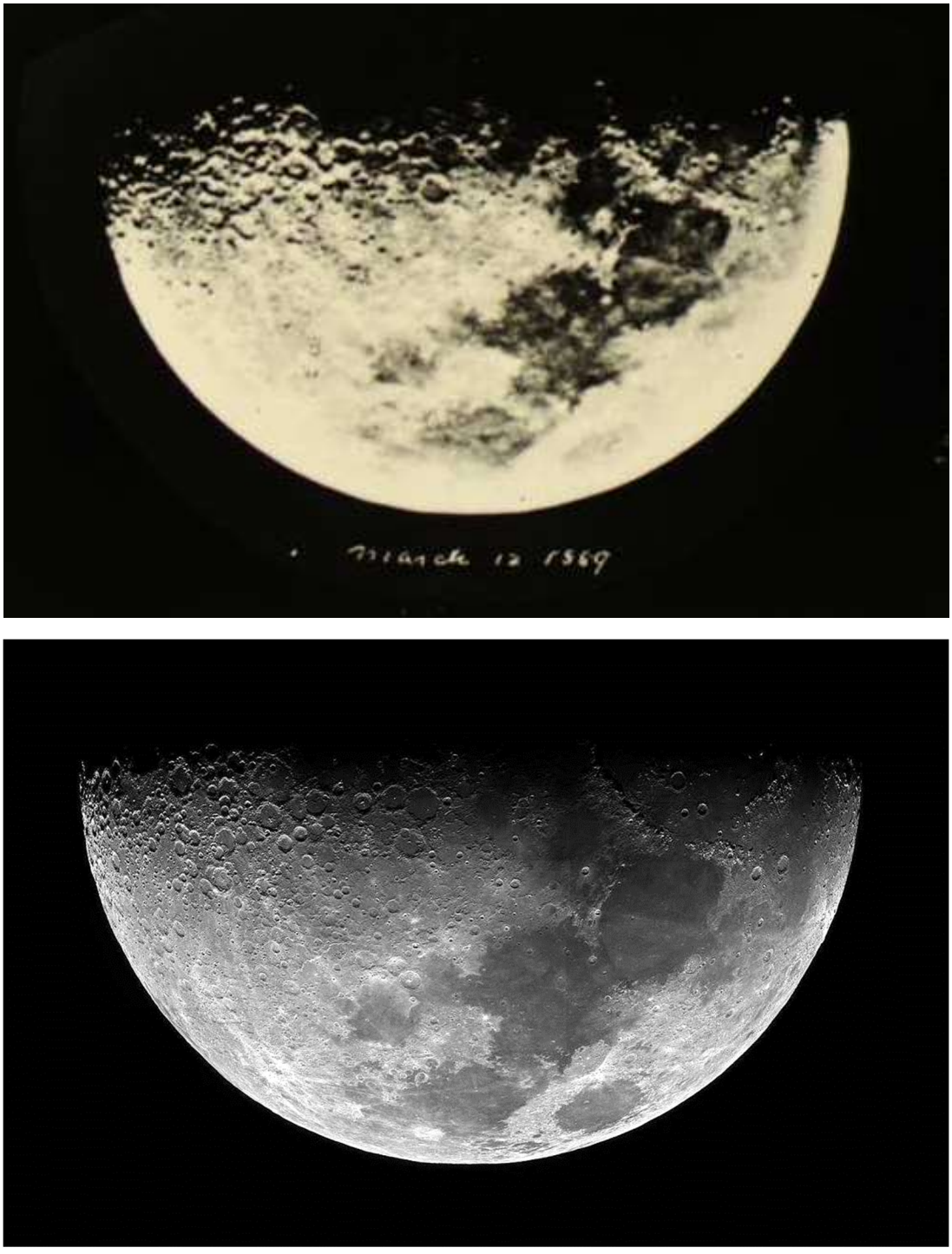
Rosette Nebula &
James Webb Space Telescope
RA 06 30 59.89 DEC +01 40 09.4 Mag 16.1
2022-01-09 06:26:30 UTC
John J. McCarthy Observatory - IAU 932

Mosaic: Takahashi FSQ-106 + ZWO ASI600MM-Pro
Inset: 16" Meade LX200 f/6.3 + SBIG ST-10XME

Astrophotography
by Marc Polansky
McCarthy Observatory

February Astronomy Calendar and Space Exploration Almanac

Eight Day Old Moon
162 Years Apart



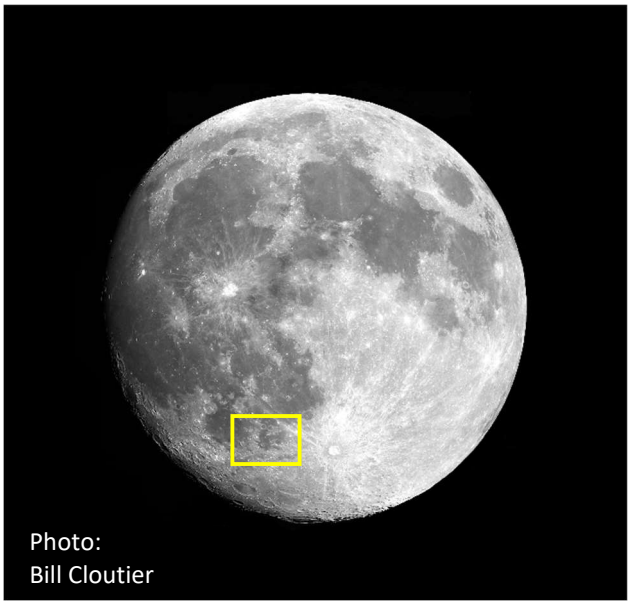
Top: John Benjamin Dancer microphotograph dated March 12, 1859
Bottom: photo mosaic with a Dancer 4.25-inch refractor on March 21, 2021

In This Issue

"Out the Window on Your Left"

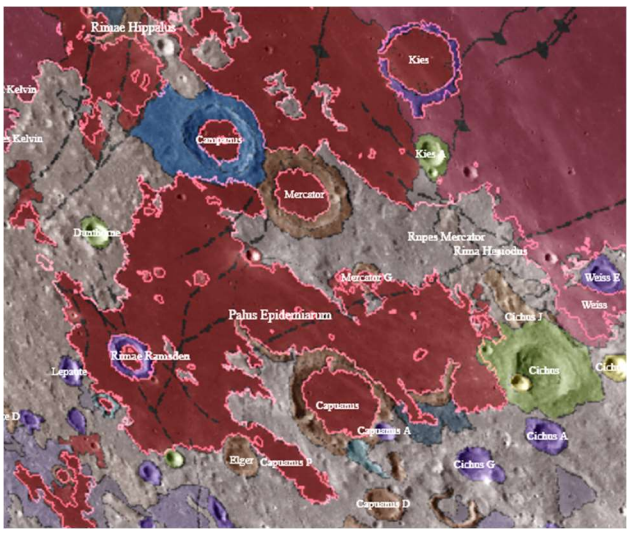
It has been more than 52 years since Neil Armstrong first stepped onto the Moon's surface and 49 years since Gene Cernan left the last footprint. As a nation founded on exploration and the conquest of new frontiers, today's commitment to return to the Moon has been as fleeting as the funding. But what if the average citizen had the means to visit our only natural satellite; what would they see out the window of their spacecraft as they entered orbit around the Moon? This column may provide some thoughts to ponder when planning your visit (if only in your imagination).

The global pandemic on Earth brought to mind a relatively inconspicuous and irregular patch of lava on the Moon, with the ominous name of Palus Epidemiarum (Marsh of Epidemics). The small lunar mare with a surface area of about 10,500 square miles (27,000 sq km) is located at the intersection of two shallow troughs, concentric to the larger impact basins, Mare Humorum to the west and Mare Nubium to the east. The western portion of Nubium lies beneath Humorum and the troughs are low lying areas between the basin's raised impact rings. The basalt that fills the mare is estimated to have an average thickness of 650 to 800 feet (200-250 meters), based on the partially lava-filled craters in the basin.



Southwest quadrant and location of Palus Epidemiarum and the adjacent impact basins

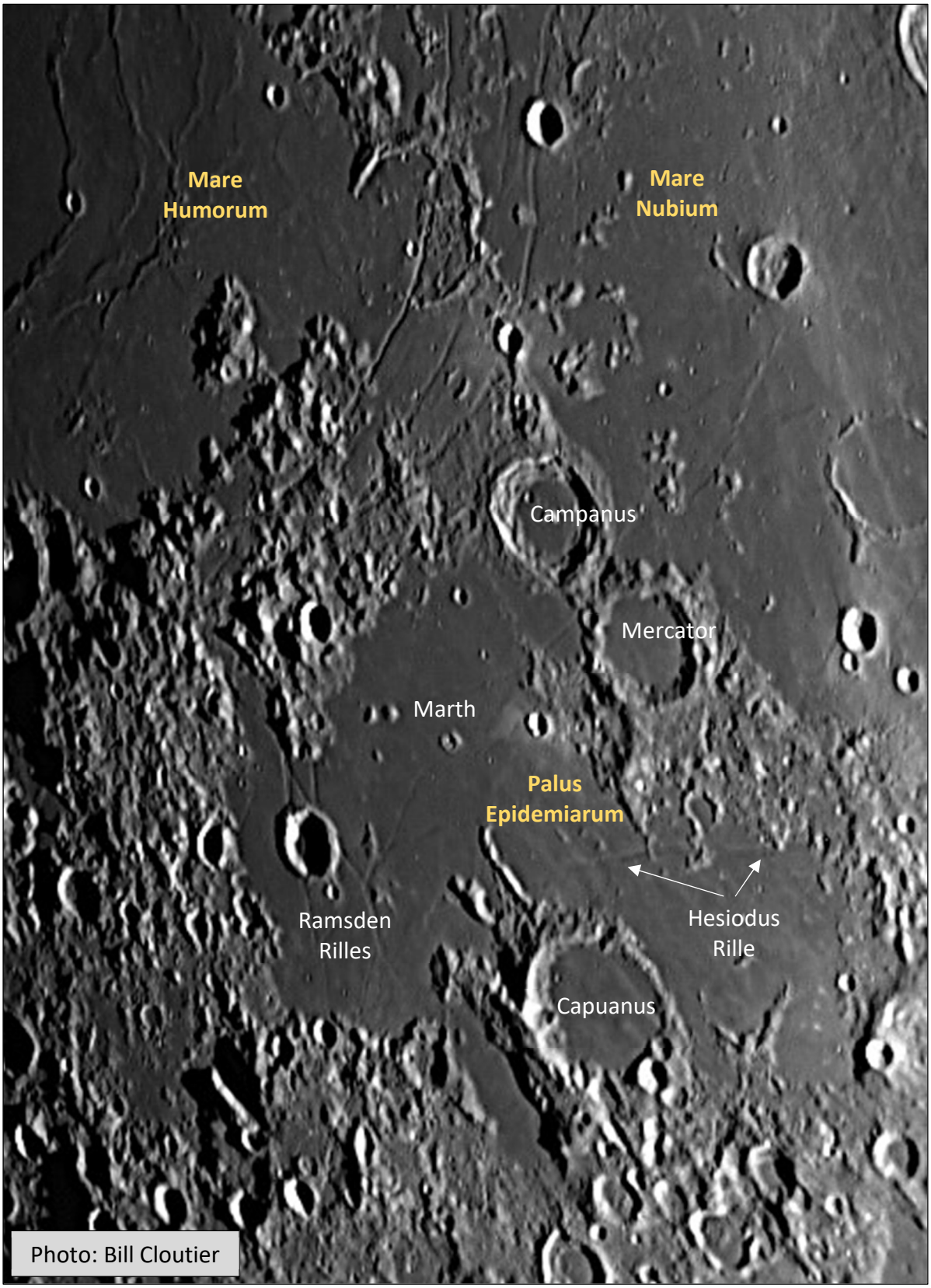
The mare first appeared on Giovanni Riccioli's map of the Moon in his 1651 "Almagestum Novum" as "Sinus Epidemiarum" (Bay of Epidemics). Although the lava patch wasn't called out in several 19th century lunar atlases, it reappeared in Johann Krieger's "Mond-Atlas" in 1912. The name was subsequently approved for use in 1935 by the International Astronomical Union, bounding a smaller area and designated as a "marsh."



Boundary of Palus Epidemiarum (dark red) Unified Geologic Map of the Moon

Palus Epidemiarum is crossed by numerous rilles or channels. Rima Hesiodus is a graben (a valley created by the subsidence between two parallel faults) that runs more than 150 miles (250 km) from the crater Hesiodus in Mare Nubium southwest, across and into Palus Epidemiarum, and ending near the partially flooded crater Capuanus. Around the crater Ramsden, at the western end of the mare, is a network of three or more rilles. There are also volcanic domes in the area, as well as the enigmatic concentric craters, including Marth for points of interest.

Palus Epidemiarum



John Benjamin Dancer

Modern photography was born in the nineteenth century and rapidly progressed from metal and glass plates covered with sometimes toxic, light-sensitive chemicals to film. Astronomers quickly realized the advantage that photography offered for capturing and recording data. Astronomer John William Draper of New York is credited with the first detailed photo of the Moon on March 23, 1840. Craters, mountains, valleys and other surface details are visible in Draper's photo of the full Moon. In February 1852, an optician from Manchester, England, by the name of John Benjamin Dancer, made negatives of the Moon with "a 4¼-inch object glass," (a telescope with a 4¼ inch diameter objective) – believed to be the first in that country.

Dancer, while an optician by trade (the quality of his workmanship was recognized in his unsolicited appointment as "Optician in Manchester to H.R.H. the Prince of Wales"), was also a citizen scientist, an inventor, a member of the Manchester Literary & Philosophical Society and Fellow of the Royal Astronomical Society. He delivered lectures in Natural Philosophy and corresponded and collaborated with colleagues, including George Biddell Airy, Charles Darwin, Sir John Herschel, James Joule, and Charles Piazzi Smyth.

Dancer is credited with introducing photography to the cities of Liverpool and Manchester. His inventions and improvements to existing scientific apparatus were numerous, although his failure to pursue patents resulted in others making claims to his original work. He experimented in chemistry, made improvements to voltaic batteries, discovered the basis of copper plating by electrolysis, and discovered ozone along the way. Dancer is credited with inventing a stereoscopic camera, micro-photographs, new forms of equatorial mountings for telescopes, and a fairy fountain with multiple water jets illuminated from below with colored lights controlled by an electric keyboard.

Dancer produced quality achromatic microscopes of various designs, rain gauges, anemometers, barometers, thread counters, surveyor levels, air pumps, spyglasses and telescopes, and a device for testing the accuracy of rifle barrels. He collaborated with Joule in a series of experiments on the production of heat by mechanical work, providing highly accurate thermometers.

Dancer Stereo Camera (Helle K. Hagen/Preus museum), Binocular Polarizing Microscope, Traveling Barometer and Altimeter

While Dancer's microphotographs were good for microscope sales, they were considered a novelty. His process for producing microphotographs, however, would yield practical applications. In 1859, a French optician, Rene Dagron was granted a patent for microfilm, using Dancer's techniques. Microfilm would be used to convey messages by carrier pigeon across German lines during the siege of Paris (1870-71) in the Franco-Prussian War. In 1925, a New York City banker received a patent for a machine designed to make permanent film copies of bank records. Kodak's Recordak Division acquired the invention and, along with the development of the 35mm microfilm camera, marketed the process for archiving and preserving documents, and as a storage medium. Microphotography was used extensively during World War II for correspondence and in espionage. In 1960, the National Microfilm Association of USA awarded Dancer a posthumous Pioneer Medal as the "Inventor of Microphotography."

Astronomy was one of Dancer's favorite studies. He observed from his observatory at the Old Manor House, as well as at those of his colleagues. He documented the 1867 solar eclipse (partial eclipse from Manchester) using a variety of instruments, including refracting telescopes with 4¼-inch, 5½-inch and 7¼-inch objectives (Dancer used a 4¼-inch refractor to view the 1870 solar eclipse). However, telescopes and objective glass receive only a passing reference in Dancer's 1873 catalogue of "Microscopes & Apparatus," suggesting that they were not a large part of his business. A search of museums, journals, auction houses and classifieds dating back to the late 1800s found reference to only 15 Dancer telescopes with objectives 4 inch and larger (likely including multiple citations to the same instrument). While Dancer's accomplishments have been veiled by the mists of time, his handiwork is still valued and commands a good price today.

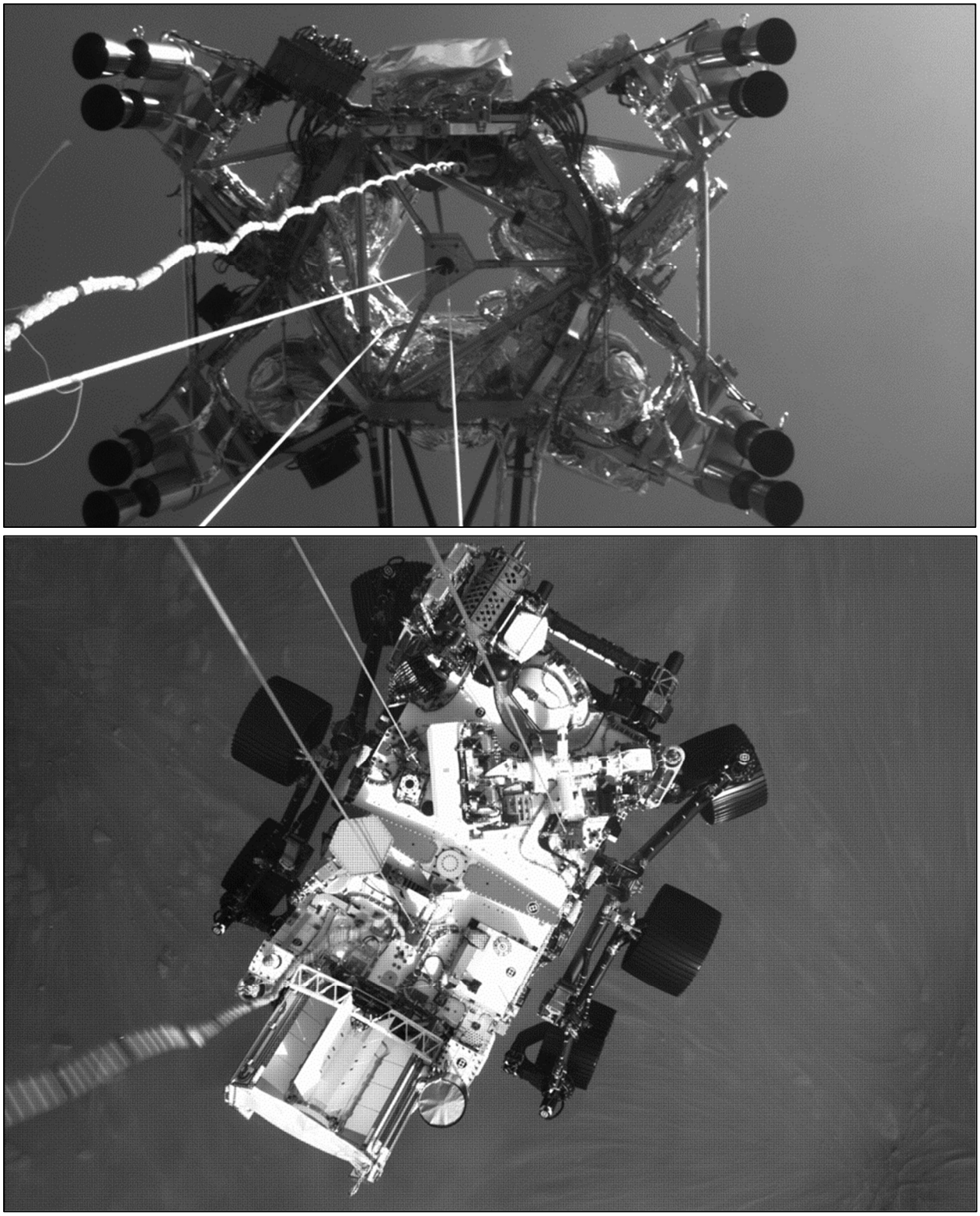
In December 2011, a 4¼-inch telescope (with a 62-inch focal length) produced by Dancer was generously donated to the McCarthy Observatory. It had been bought at a London auction in 1976 and was in need of some repair. The diameter of the objective lens is identical to that used by Dancer to photograph the Moon in 1852, although the field tripod that came with the telescope would not have been suitable for long exposures. Acquiring an antique scientific instrument is fraught with decisions on how best to showcase its historical significance. After much debate and consultation with subject matter experts, the decision was made to restore the telescope so that it could once again be used to view the heavens and offer a personal connection to astronomy.

The restoration of this 19th century gem was due to people like Ms. Claire Wilkie (great-great granddaughter of Dancer) for her encouragement, Robert Royce (President of Precision Optical Components) who cleaned and reinstalled the two element objective (that had been reversed at some point in the past), Gene Shilling (master carpenter) who replicated a broken tripod leg, and, in particular, Dick Parker (amateur telescope maker and master machinist), who donated considerable time and effort in repairing the focuser rack, reattaching the focuser body to the telescope back plate, straightening the finder brackets, repairing the mahogany case, and machining a brass slip tube to accommodate modern 1¼ inch eyepieces.

First light for the restored Dancer telescope along with a screen shot of Mare Tranquillitatis (Sea of Tranquility) from a video taken with the telescope Photos: Bill Cloutier

21st century photos taken with the 19th century Dancer telescope Photos: Bill Cloutier

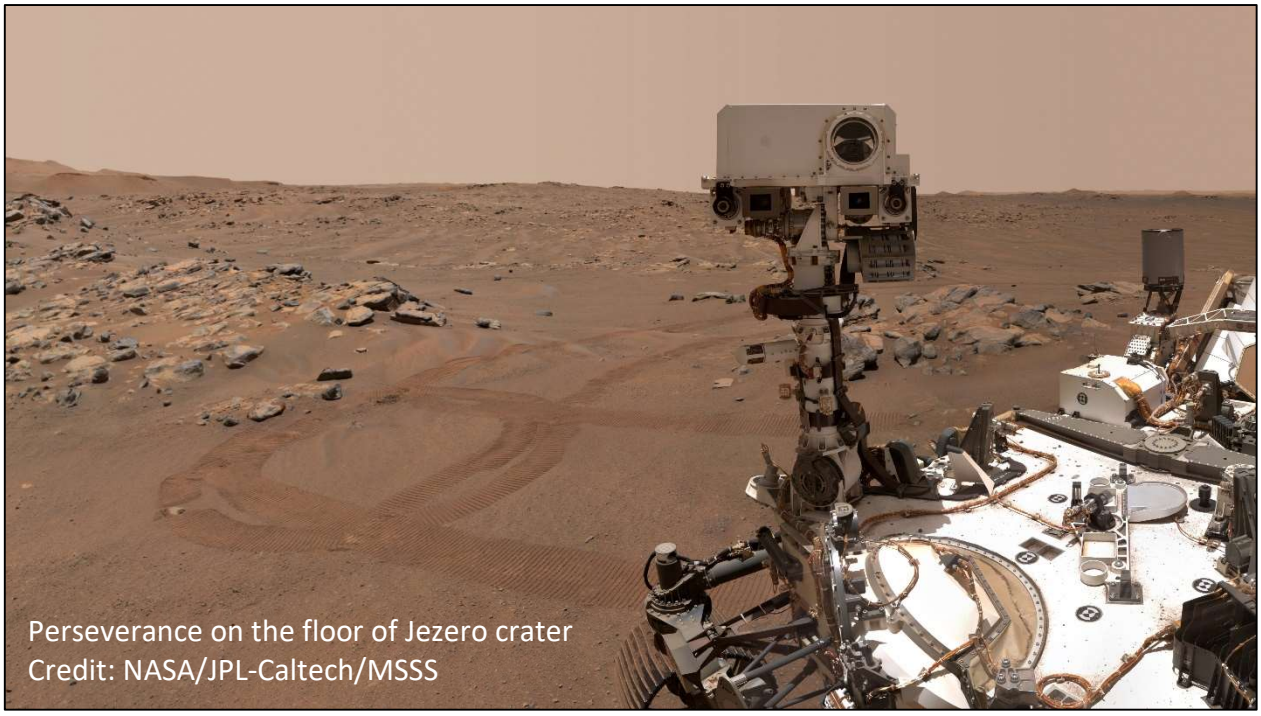
Perseverance's First Earth-Year on Mars



The descent stage (top) lowered the 2,260-pound (1,025 kg) Perseverance rover (bottom) the final 66 feet (20 meters) onto the Martian surface on February 18, 2021
Images: NASA/JPL-Caltech

On February 18, 2021, around 3:30 in the afternoon (EST on Earth), after a journey of seven months and almost 300 million miles (480 million kms), the Mars 2020 spacecraft entered the Martian atmosphere for a seven-minute, high-speed ride down to the surface. At that time, Earth was 127 million miles (204.85 million km) or 11 light-minutes from Mars, so by the time engineers at NASA's Jet Propulsion Laboratory received the signal from the spacecraft that Entry, Descent and Landing (EDL) had begun, the rover had been on the surface for four minutes.

NASA targeted an ancient river delta within Jezero crater for its latest rover, named Perseverance, to explore. Jezero crater, 28 miles (45 km) across, is located on the perimeter of a level plain called Isidis Planitia, just north of the Martian equator. Based upon the data collected by orbiting spacecraft, the 3.9-billion-year-old crater was likely flooded in the distant past, with a paleolake containing as much water as Lake Tahoe on Earth. Similar in appearance to the Curiosity rover/mobile laboratory, which is exploring Gale crater, Perseverance is equipped to look for signs of early microbial life that might be preserved within the clay strata at Jezero crater.

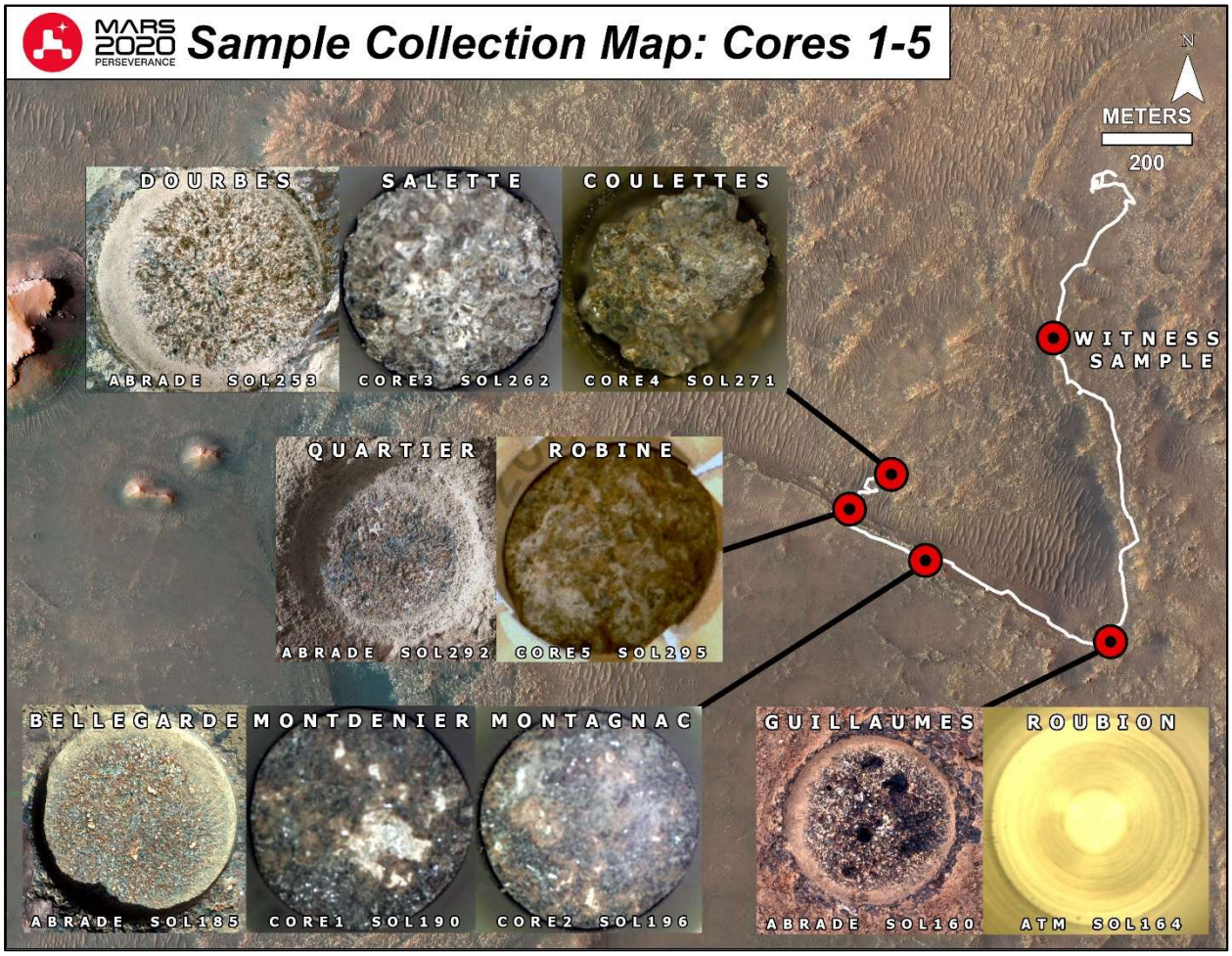


Perseverance on the floor of Jezero crater
Credit: NASA/JPL-Caltech/MSSS

In the past Earth-year, Perseverance has driven more than 1.8 miles (2.9 km), skirting a dune field in front of the delta. It has transmitted more than 50 gigabytes of science data and 100,000 images of its surroundings. One of the objectives of the mission is to collect core samples for eventual study back on Earth. The rover is equipped with a sophisticated caching system which is used to transfer the rock cores from the drilling apparatus at the end of its arm and seal them into 6 inch (15.2 cm) long titanium tubes (there are 43 tubes, several that will be used as witness samples – measuring any contamination that might be attributable to rover operations). The sample tubes will be left at an easily identified location on the surface for retrieval by a future mission.

Sample acquisition has had its challenges. The first rock targeted failed to produce a core as the material inside the drill bit crumbled, leaving the sample tube empty (the tube was used for a sample of the Martian atmosphere). The next five attempts were successful. The sixth core, taken in late December, included small pebbles that ended up sitting in the carousel and preventing the robotic arm from transferring the tube for sealing and storage. JPL engineers were able to clear the

debris in late January. In the process of sampling, the rock face is first abraded to remove the weathered layer. Prior to coring the fresh surface, Perseverance has used its other instruments, such as PIXL, (Planetary Instrument for X-ray Lithochemistry), to map the elemental composition of the rock. The results have provided some insight on geologic history of the crater floor.

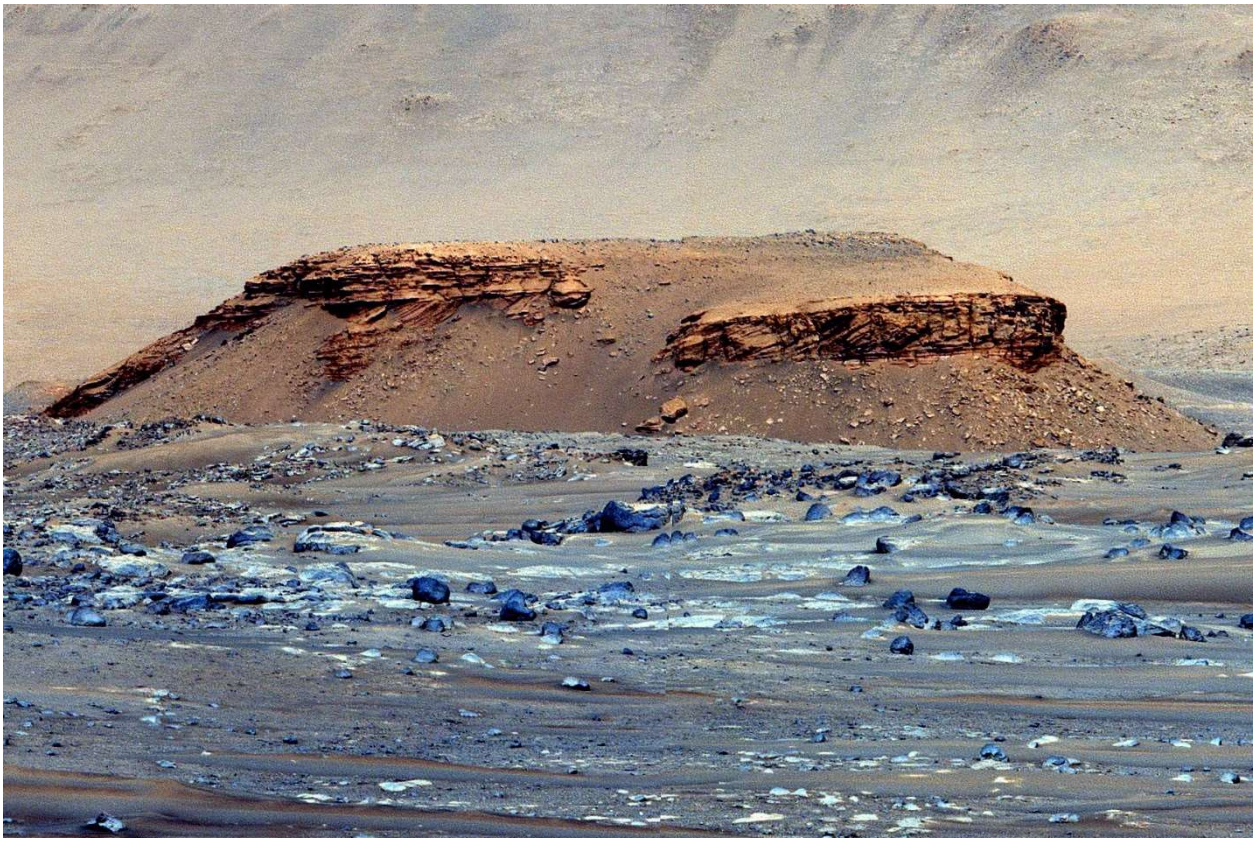


Location of first witness tube, initial sample attempt that didn't produce a core and subsequent five successful cores (through Sol 295 (Dec 18, 2021)
Credit: NASA/JPL-Caltech/ASU/MSSS

PIXL's detection of olivine and pyroxene crystals indicate a slowly cooling lava lake or magma chamber, although it's not clear if lava flowed across the surface of the crater or was exposed through erosion of the overburden. The rock also shows signs of being altered by water, on multiple occasions, over eons.

The rover's SHERLOC instrument (Scanning Habitable Environments with Raman & Luminescence for Organics & Chemicals) detected carbon-containing molecules in the abraded rocks, as well as in the dust on non-abraded rock. Organics are the building blocks of life, but non-biological processes can also create organics. However, the preservation of organic molecules means that biosignatures (signs of life, past or present) could also be preserved. The answer may have to wait until the samples are returned to Earth where more state-of-the-art technologies can be applied.

Perseverance is also looking below the surface with its RIMFAX (Radar Imager for Mars' Subsurface Experiment) ground-penetrating radar. The instrument, which can map subsurface features to a depth of 33 feet or 10 meters, has revealed that the angled rock formations seen on the surface continue downward with a similar tilt.



False color image of a delta remnant informally named “Kodiak” and large boulders
Credit: NASA/JPL-Caltech/LANL/CNES/CNRS/ASU/MSSS

Once on the ground, it didn’t take Perseverance long to confirm what had been inferred from orbit – that Jezero was the site of an ancient Martian lake in which a river delta had formed at the crater inlet. Long-range images of the delta show layers of sedimentary rock. The tilted deposits depict a time period – estimated at between 3.6 and 3.8 billion years ago, when the lake was more tranquil, with inlet channels filling the crater and an outlet channel maintaining a constant level. The layers of sediment were slowly deposited at this time period.

The large boulders in and on the youngest layers tell another story, one of flash floods and dynamic changes in the watershed and Martian climate. A raging river would have been needed to carry the boulders, some estimated to weigh several tons, tens of miles (km) downstream.

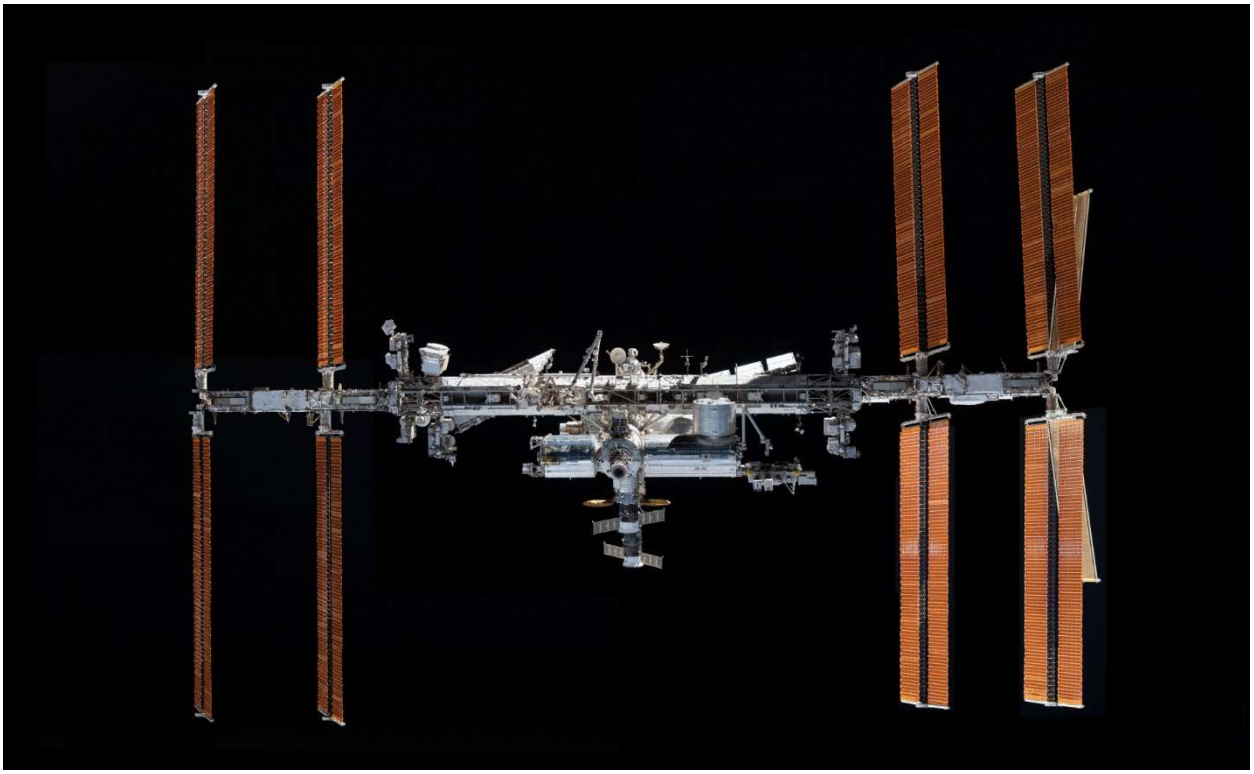
Perseverance is currently heading back to the landing site, informally named Octavia E. Butler, circumventing a large dune field between the rover and the main delta. It will then drive in the opposite direction, counterclockwise, around the northern portion of the dune field, negotiating a pathway between the dunes and craters to the west and uneven terrain to the east, to reach the face of the delta. Scientists believe that the fine-grained material located at the bottom of the delta holds the best chance to find signs of ancient life.

Perseverance carried two technology demonstrations to Mars: MOXIE and Ingenuity. MOXIE was designed to validate a process to pull oxygen out of the carbon dioxide atmosphere. The toaster-sized experiment was successful in extracting a few grams of oxygen in its one hour of operation. A more powerful unit could provide future colonists with oxygen to breath and oxidizer for rocket fuel, reducing the need to transport it from Earth.

Ingenuity is a small helicopter specifically designed to fly in the rarified Martian air. Bolted to the belly of the rover, it was deployed in April of 2021. NASA allocated a 30-day flight window for the flight test. The intrepid little rotorcraft took to the butterscotch skies like a natural, flying higher and further with every flight. Nine months and eighteen flights later, what started out as a proof-of-concept has now transitioned into an operation's demonstration, as Ingenuity is now performing as a scout for Perseverance and providing terrain imaging of areas inaccessible to the rover.

Ingenuity
Credit: NASA/JPL-Caltech

Life Extension



The International Space Station as seen from the SpaceX Crew Dragon during a fly-around following its undocking on November 8, 2021

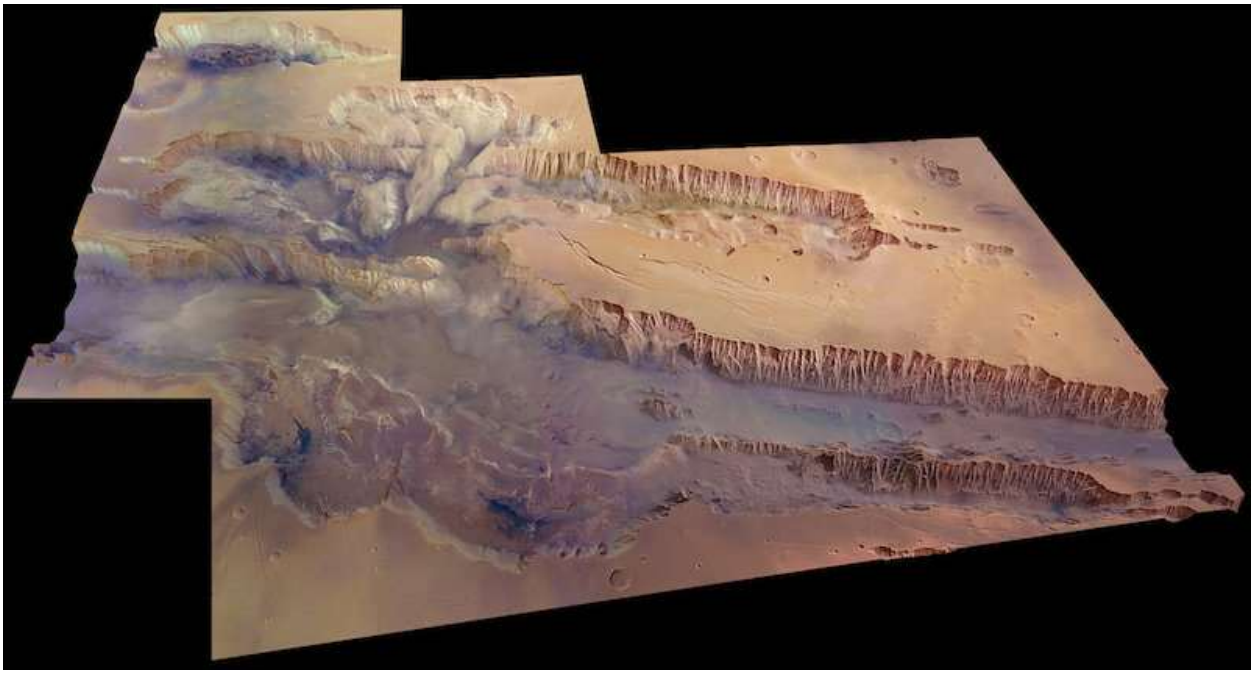
Credit: NASA Johnson

The Biden-Harris Administration has committed to extending International Space Station (ISS) operations through 2030. While the ISS is a partnership among the United States (US), Russia, Canada, Japan, and 11 European countries working through the European Space Agency, the US leads the negotiations with the other members on issues such as whether to continue operations of the 22-year-old space station, which has been continuously occupied since 2000.

The ISS is comprised of two major segments: the Russian Orbital Segment and the US Orbital Segment (the US segment includes modules from Japan and Europe, as well as Canada's remote manipulator system). Solar panels on the US segment provide power to the orbiting laboratory while engines on Russia's Zvezda Service Module and Progress cargo ships are used to maintain station orientation and to periodically reboost the ISS. Mission control centers are located in both Moscow and Houston.

The 2030 date represents a six-year extension from the year 2024 authorized by Congress in 2017. The new date has been proposed within several pieces of legislation, but none have cleared Congress. Along with Congress, a consensus is needed among the partners, including Russia. Relations between the US and Russia have been strained since Russia annexed Crimea, a part of Ukraine, in 2014. As recently as last year, Russian Deputy Prime Minister Yury Borisov suggested Russia would leave the ISS partnership as early as 2025, taking their modules along with them to construct a national space station. As with past threats, no formal action has been taken.

Searching for Water in Vallis Marineris



Valles Marineris canyon system from the European Space Agency's Mars Express orbiter

Credit: ESA/DLR/FU Berlin (G. Neukum), CC BY-SA 3.0 IGO

The joint European-Russian Trace Gas Orbiter (TGO) has detected water (actually hydrogen, the primary component) in Valles Marineris. The canyon system runs from the Tharsis region along the Martian equator (about 20 percent of the planet's circumference) and is believed to be a tectonic fracture in the crust, likely related to the adjacent uplift upon which the massive shield volcanoes reside. Valles Marineris is 5 times longer and 4 times deeper than the Grand Canyon on Earth. Some of the channels within the canyon appear to have been altered by water.

TGO found the water using its FREND (Fine Resolution Epithermal Neutron Detector) instrument. Neutrons are produced from the interaction of galactic cosmic rays (high energy radiation, composed of primarily protons, but also including heavier elements) with the Martian soil. The moisture content affects the production, with drier soil yielding more neutrons than wetter soil, which in turn can be correlated to the hydrogen content. FREND is able to scan the subsurface of the canyon to a depth of 3 feet or 1 meter.

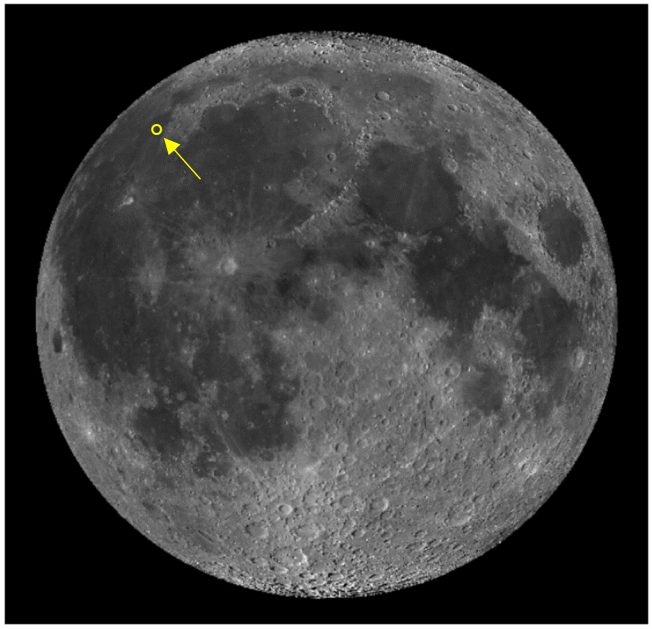
According to researchers, the water-rich area is located in the central part of the canyon complex, in a region called Candor Chaos. The subsurface soil is estimated to contain up to 40% water, most likely in the form of ice. The presence of subsurface, equatorial ice has been likened to permafrost on Earth where water ice resides under a layer of dry soil due to persistently low temperatures.

TGO, part of the ExoMars program, has been orbiting the Red Planet since 2016. It will be joined by the Rosalind Franklin rover in 2023. Originally planned to launch in 2020, with a March 2021 landing in Oxia Planum, issues with the Russian descent and lander modules delayed the launch to the next planetary alignment in 2022. The rover is equipped to detect life, past or present, on the surface of Mars.

Lunar Water

China's Chang'E-5 spacecraft landed on the northern expanse of the Moon's Oceanus Procellarum (Ocean of Storms) in December 2020, returning nearly two kilograms of rocky fragments back to Earth sixteen days later. It was the first lunar sample return mission in 24 years (the last samples returned were by the Soviet Union's Luna 24 mission).

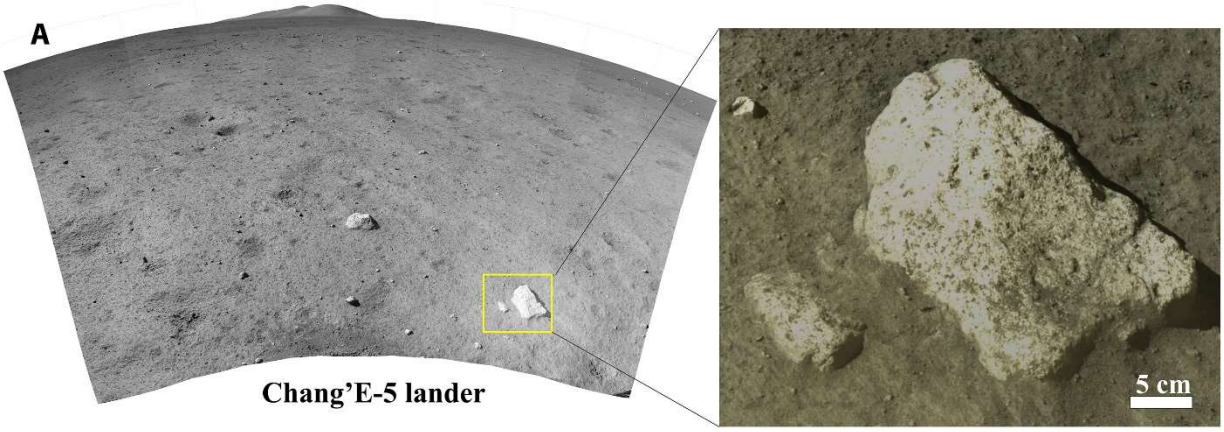
Chang'E-5's landing site appears to be considerably younger than other basaltic flows targeted by the Apollo and Soviet missions (all the Apollo volcanic samples were older than 3 billion years). Radiometric dating of the Chang'E-5 samples yielded an age of about 2 billion years, although a source of the magma has not yet been identified.



Location of Chang'E-5 lander
Source: Lunar QuickMap

The Chinese lander was equipped with a spectrometer. The instrument was used to analyze local mineral composition and look for signs of water. The results of the site survey were recently released and confirm the detection of water, although at very low levels, in the surrounding regolith (estimated at 120 parts per million (ppm)). The measurements are consistent with the preliminary analysis of the samples that were collected at the site.

The water detected by the Chinese spectrometer has been attributed to the solar wind where hydrogen streaming from the Sun bonds with oxygen on the lunar surface to form hydroxyl (one oxygen bonded to one hydrogen atom) and/or water molecules.



Not far from the lander was a light-colored rock (named as CE5-Rock). The water content of CE5 was estimated at ~180 ppm, significantly higher than the surroundings. Scientists believe that the rock may have come from the Moon's interior, excavated by an impact that also transported CE5 to the Chang'E-5 landing site. If true, the Moon's interior may contain reservoirs of water-rich minerals that could be exploited by future colonists.

X-Ray Vision

Cassiopeia A supernova remnant
Credits: NASA/CXC/SAO

NASA's newest X-ray observatory has started science operations. The Imaging X-ray Polarimetry Explorer (IXPE) was launched on December 9 into an orbit 370 miles (600 km) above Earth's equator. The observatory is comprised of three identical telescopes, each with a mirror assembly and a polarization-sensitive detector. The detectors needed to be about 13 feet (4 meters) away from IXPE's mirrors for focus. Too large for most rocket fairings, the boom separating the mirrors and detectors was folded into a 12-inch (0.3-meter) cannister for launch and deployed once in orbit. The next three weeks were spent aligning the telescopes and checking out the observatory's steering and positioning systems.

IXPE's first science target (which it began observing on January 11) is Cassiopeia A, or Cas A, a supernova remnant. IXPE is a joint effort between NASA and the Italian Space Agency. It is the first space observatory dedicated to studying the polarization of X-rays emitted from high-energy sources like supernova, neutron stars and black holes. Observations of Cas A are expected to last about three weeks.

Meteorite Spotlight – Sikhote-Alin

In the summer of 2018, the Observatory greatly expanded its meteorite teaching collection with the addition of a diverse and comprehensive set of meteoritic specimens from a reputable collector looking to convey his collection to someone who would maintain its integrity and capitalize on its intrinsic educational value. The collection includes whole stones, slices and fragments, numbering more than 200, from historic and scientifically-significant falls and meteorite finds dating back to 1492. From time to time, we will highlight one or more of the specimens from the collection in this newsletter.

Regmaglypts on the Sikhote-Alin meteorite
Photo: Bill Cloutier

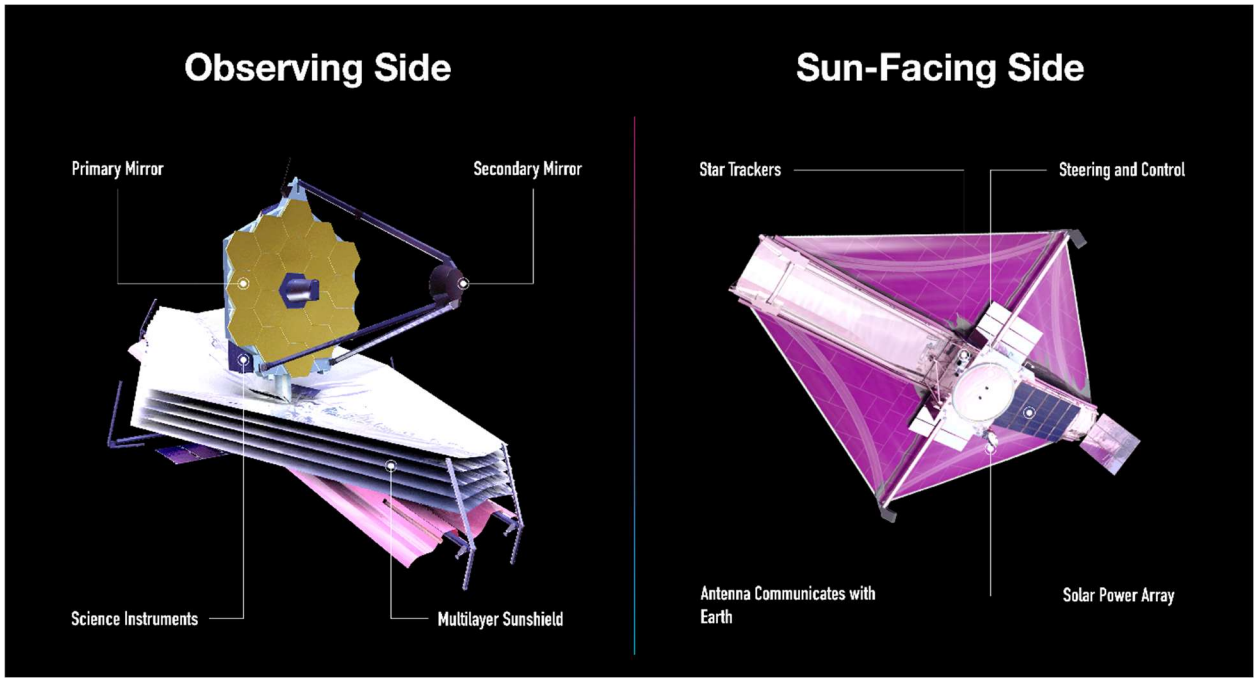
On the morning of February 12, 1947, a fireball streaked across the sky over the Sikhote-Alin Mountains, northeast of Vladivostok, Russia. According to eye witnesses, the fireball appeared to arrive from the north and was brighter than the Sun before breaking into smaller pieces. The largest meteor fragment exploded at a relatively low altitude (estimated at 3.5 miles or 5.6 km) and was seen and heard as far away as 200 miles (320 km). The pre-atmospheric mass was estimated at 100 tons, of which 23 tons was ultimately recovered (the largest witnessed fall of an iron meteorite). The fall created a large field of impact craters and pits containing individual pieces, as well as shrapnel (from hitting the frozen ground).

Many of the intact specimens have thumbprint indentations called regmaglypts. These features are formed shortly after the asteroid enters the atmosphere. The high-speed entry (the meteor was estimated to have been traveling in excess of 30,000 mph or 14 km/s) compresses and heats up the atmosphere (ram pressure), melting the iron-nickel and ablating certain components.

The McCarthy Observatory has a 127-gram sample of Sikhote-Alin in its Pavell collection.

Webb Arrives at L2

More than a month after its Christmas morning launch, the James Webb Space Telescope (Webb) has reached its final destination, almost a million miles (1.5 million km) from Earth. Due to its large size the Webb was designed to be folded up into a configuration that would fit inside the Ariane 5's rocket fairing like an origami sculpture. The infrared telescope with a 21.3-foot (6.5 meter) diameter primary mirror was released from the upper stage about 28 minutes after liftoff. While a successful launch was celebrated, mission success depended upon the choreographed deployment of the various components of the deep space observatory - 344 single points of potential failure with all the pins and latches that had to release or lock, and associated motors and pulleys that had to function in the cold vacuum of space.



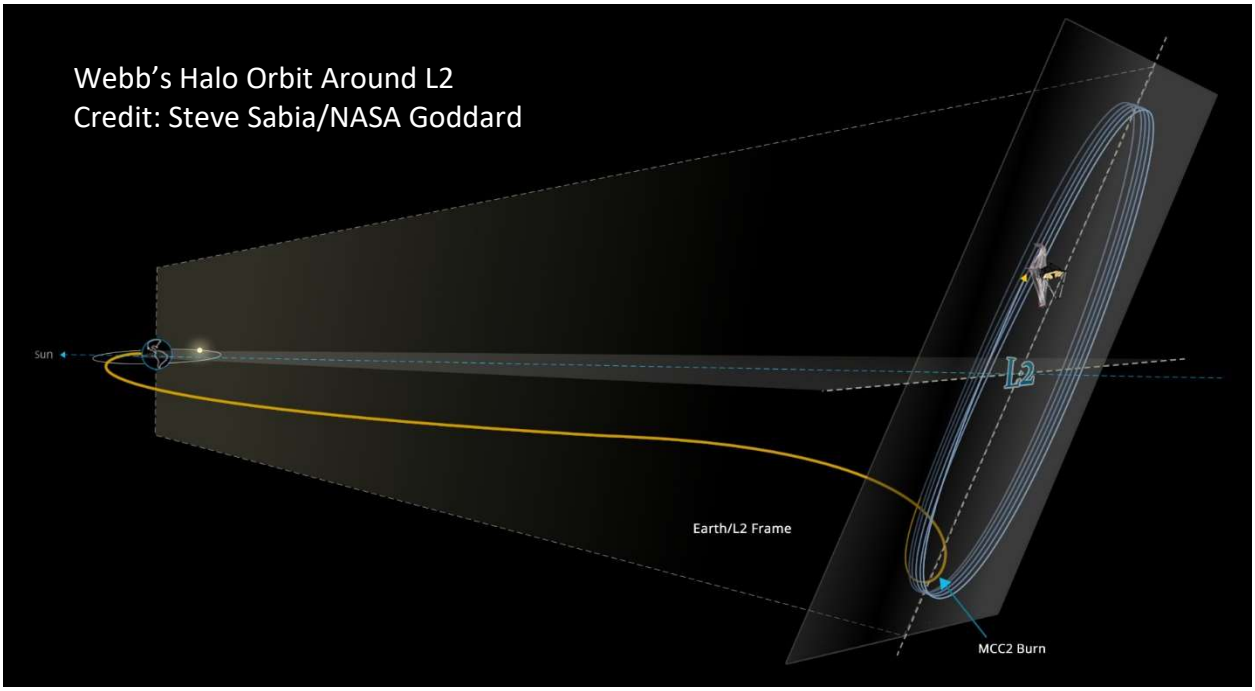
Artist's conception of the Webb space telescope will all its components fully deployed
Image: NASA, ESA, CSA, Joyce Kang (STScI)

The telescope's solar panel was deployed shortly after separation, providing power to the spacecraft's attitude control system. Approximately 12 hours later, the spacecraft successfully executed a 65-minute burn, the first and most critical, that sent the telescope out toward the second Lagrange point or L2, a million miles from Earth. Slowly over the days that followed various components were released into their operating configuration and/or powered on.

Shortly after beginning its journey to the second Earth-Sun Lagrange Point, commonly referred to as "L2.", engineers began to unfold the sunshield – an eight-day process. The five-layer (each layer is about the thickness of a human hair and coated with reflective metal), tennis court-sized sunshield, is a critical component, allowing the telescope and its detectors to operate at the extremely low temperatures required for science operations (as low as 7°K (-447°F/-266°C). By January 4, the Webb's sunshield was fully deployed and tensioned. Four days later, the two wings of the primary mirror, each comprised of 3 gold-coated beryllium mirrors, were rotated into place, joining the 12 hexagonal stationary segments to form a single mirrored surface equivalent to 21.3

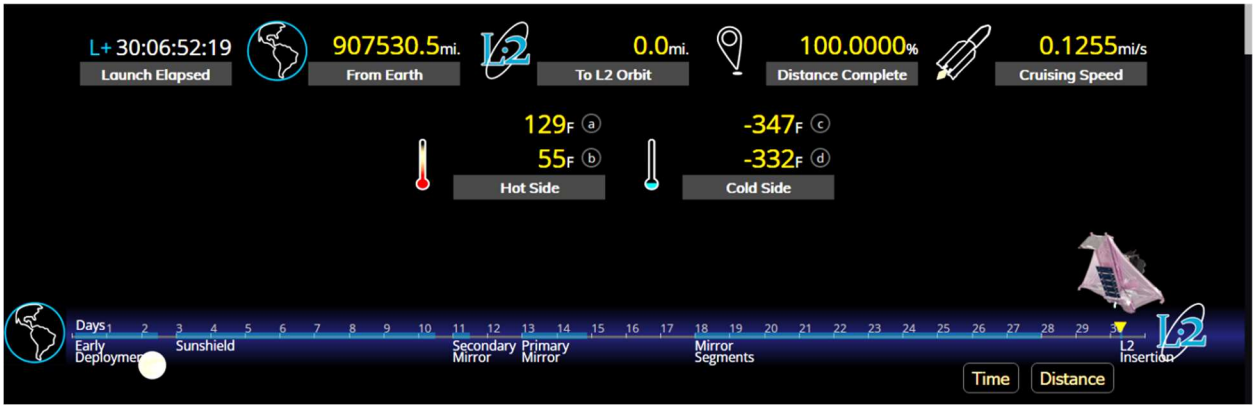
feet (6.5 meter) in diameter. The 18 mirrors have now been moved out of their launch positions and, over the next three months, will be aligned to work as one.

On January 24, the Webb's thrusters inserted the space telescope into orbit around the Sun at the L2 point. Once the mirrors are aligned and instruments calibrated, the telescope can commence science operations. Commissioning, which is expected to take as long as six months will be followed by a preliminary science campaign (putting the telescope and its detectors through the rigors of observing various types of targets).



The infrared telescope will be able to look back to a time in the early universe when the first stars and galaxies formed, over 13.5 billion years ago. It will also be able to peer inside dust clouds to where stars and planetary systems are forming, as well as analyze the atmospheres of exoplanets. NASA's James Webb Space Telescope is a joint effort with the European Space Agency and Canadian Space Agency.

Upon arrival at L2 (907,530.5 miles or 1,460529.2 km from Earth) the average temperature of the hot side of the sunshield was 129°F (54°C), the hot side of the spacecraft equipment panel was 55°F (13°C), the cold side of the primary mirrors was -347°F (-211°C), and the cold side of the instrument radiator was -332°F (-202°C).



Twenty-Five Years Ago

On February 21, 1997, at 3:32 a.m. EST, the space shuttle Discovery returned to the Kennedy Space Center after a 10-day mission (STS-82) that included servicing and upgrading the Hubble Space Telescope (the second of five missions). The telescope had been grappled by the shuttle's robotic arm and placed in the cargo bay where it was worked on during five extravehicular spacewalks. Discovery's astronauts removed the Goddard High Resolution Spectrograph and Faint Object Spectrograph, replacing them with the Space Telescope Imaging Spectrograph and Near Infrared Camera and Multi-Object Spectrometer, respectively. They replaced other components including one of four Reaction Wheel Assemblies (used to move the telescope towards a target and maintain position), as well as repaired the telescope thermal insulation. Discovery's maneuvering jets were then used to boost Hubble's orbit before the telescope was released.

The space shuttle has 4 main landing gear tires and 2 nose landing gear tires. The larger, main gear tires take the brunt of the load during landing and are, with few exceptions, only used once (the nose gear tires can be used twice). Made with a minimum amount of tread (to save weight), the 34-ply main landing gear tires are inflated to 340 psi (nitrogen is used due its stability at different temperatures and pressures) and rated for 263 mph (423 k/h). While ST-82 traveled a total of 4.1 million miles (6.6 million km), the tires were only used during the last 60 seconds of the mission, for the final 7,066 feet (2,154 meters) on the Kennedy Space Center runway.

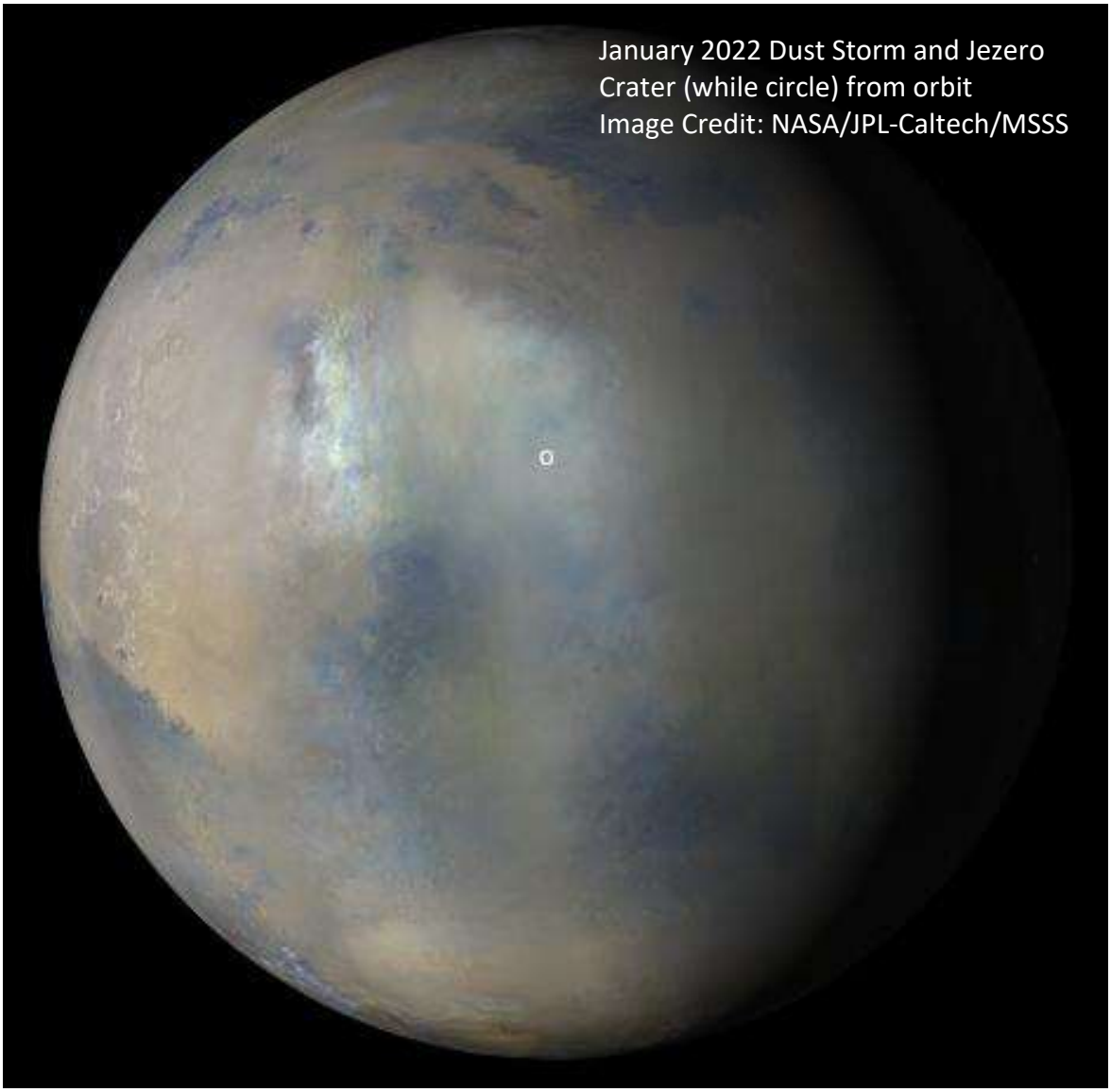
One of the main landing gear tires from the ST-82 mission, originally installed on Discovery's right, inboard side (there are two tires on each main gear), is displayed outside the McCarthy Observatory. On loan from NASA, the Michelin Air tire (Michelin acquired the BFGoodrich aircraft tire division in 1989) may look like an ordinary truck tire, but it can carry 3 times the load of a Boeing 747 tire and withstand rapid changes in temperature during reentry from -40°F to +130°F. During production, each shuttle tire took about six hours to build.

STS-82 Shuttle Tire
Outside the McCarthy
Observatory

Nighttime landing of STS-82
Photo: NASA

Martian Weather Disruptions

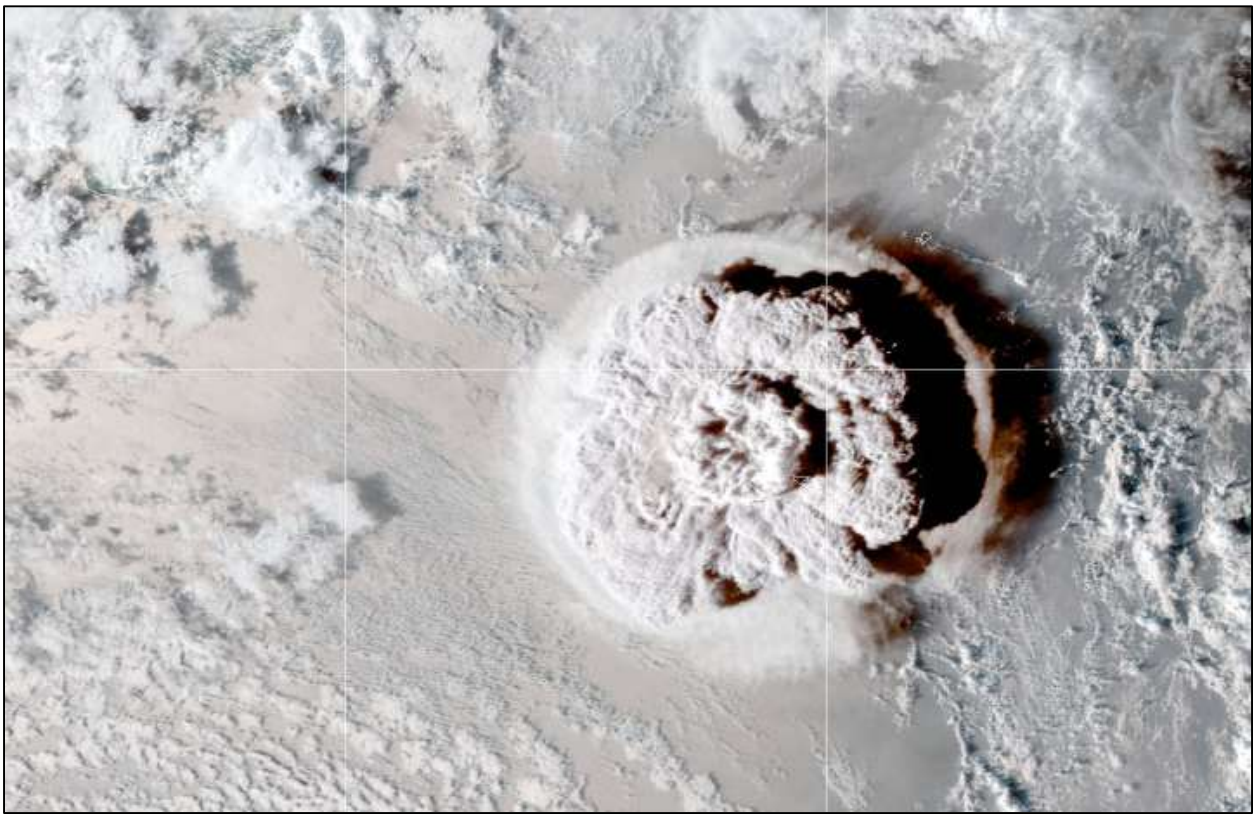
Although the atmosphere of Mars is extremely thin (with a mean surface pressure less than 1% of Earth's), it is still capable of supporting weather events, specifically dust storms that can propagate across the entire globe. While NASA's nuclear-powered rovers are immune from the effects of atmospheric dust, solar-powered explorers and landers are not (the Mars Exploration Rover Opportunity was active for more than 14 years, trekking over 28 miles or 45 km, before a global dust storm turned day into night and killed its solar-panel-charged batteries).



While winter is normally the dusty season on Mars, 2022 started off with an unusually strong late-summer storm that came out of the southern hemisphere to obscure the skies over Jezero crater, where the Perseverance rover and Ingenuity helicopter are exploring, as well as at InSight's location more than 2,000 miles (3,400 km) away. Perseverance's weather station recorded a 7% decrease in air density and about an 18% decrease in sunlight during the dust storm. As a result, the InSight lander went into a safe mode and the helicopter was grounded. The storm has since cleared and JPL engineers are working to assess the effects on power production from dust accumulated on InSight's solar panels and to resume flight operations for Ingenuity.

NASA's Disaster Program

NASA's Earth Observing System (EOS) is "a coordinated series of polar-orbiting and low inclination satellites for long-term global observations of the land surface, biosphere, solid Earth, atmosphere, and oceans." The agency has 30 missions currently flying with four additional Earth science missions scheduled to launch in 2022. NASA's unique perspective of the Earth is shared with the public though media outlets and websites such as the "Earth Observatory."



GOES-West satellite captured this image of the Tonga volcanic eruption on January 15
Credits: NASA Worldview, NOAA/NESDIS/STAR

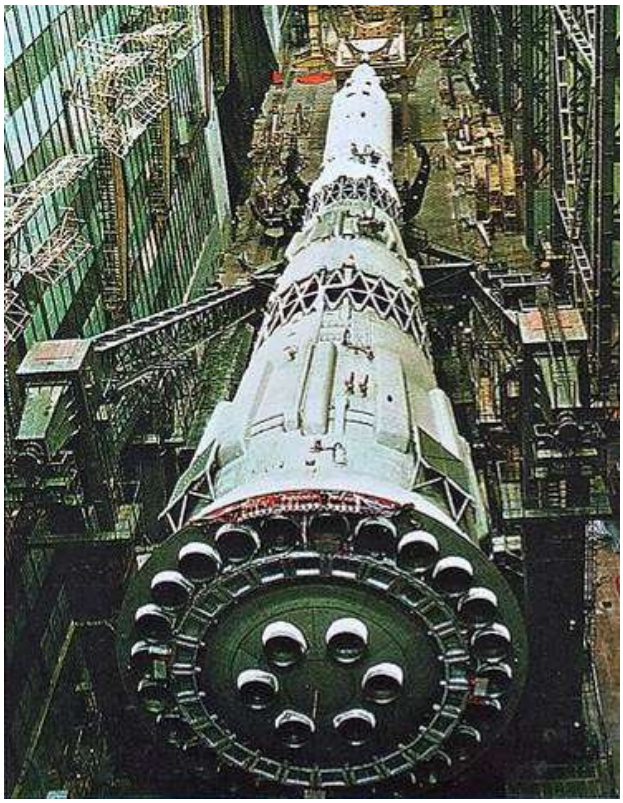
NASA also has a "Disasters" program which uses Earth-observing data to improve the prediction of, and response to, disasters around the world. Multiple space-based assets were recently used to study the submarine eruptions of Hunga Tonga Hunga Ha-apai. The explosive eruptions generated atmospheric shock waves, sonic booms, and tsunami waves. The ash cloud, visible from space, grew to a diameter of about 300 miles (500 km) and within it almost 400,000 lightning events were recorded. The sulfur dioxide mass of the plume of 400,000 tons was derived from satellite-based estimates. NASA's Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) detected ash and gas from the eruption rising to an altitude of 19 miles (31 km) - a small amount may have reached as high as 24.7 miles (39.7 km).

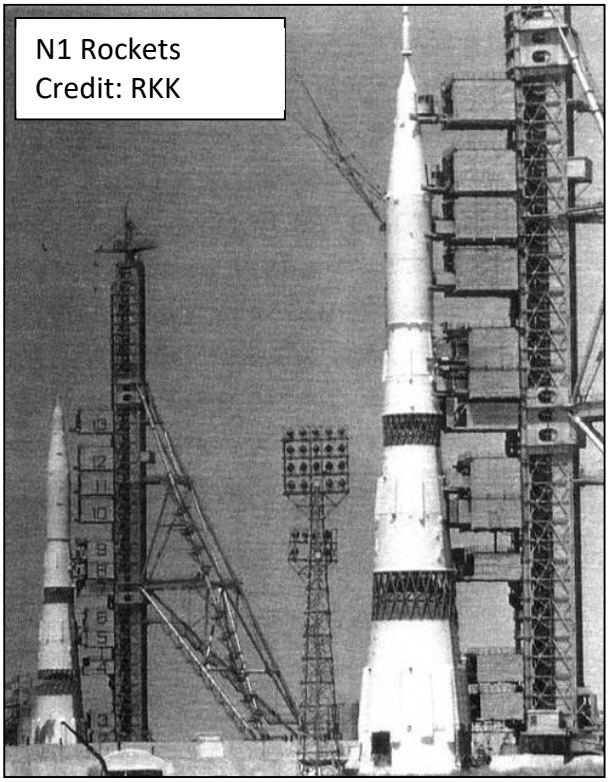
Images from NASA's Aqua satellite show that the small islands situated on the rim of the submarine caldera were obliterated by the 10-megaton eruption. Buildings and infrastructure on nearby islands, likely damaged by the eruption, were identified using the synthetic aperture radar on the European Space Agency's Copernicus Sentinel-1 satellites. The collective information from these space-based assets has been used to direct aid to the region.

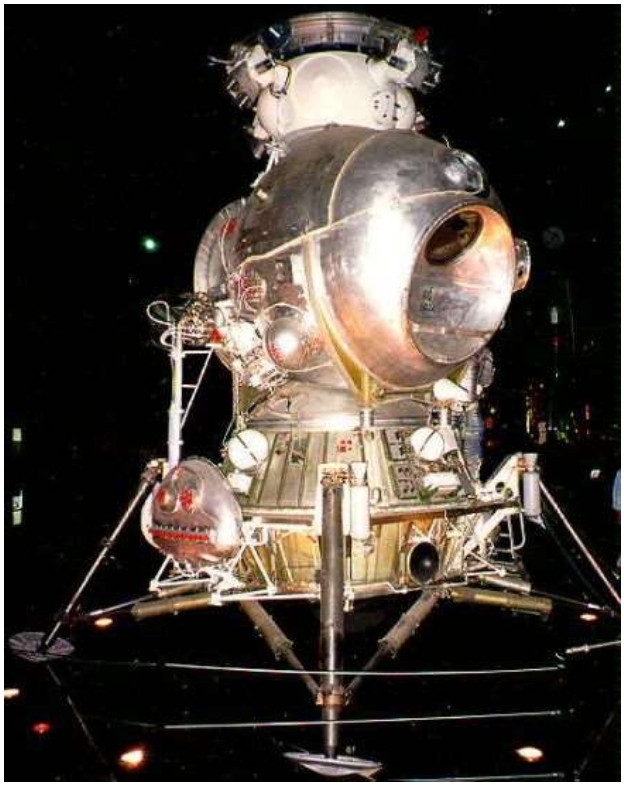
Soviet Moon Program

February 1969 marked the beginning of the end of the Soviet Moon program. While publicly denying its intentions to send cosmonauts to the Moon during the 1960s, the Soviets were secretly constructing rockets of mammoth proportions (rivaling the Saturn V). On February 21, 1969, the N1 moon rocket exploded during its first test flight. The rocket fell back to Earth after a safety system mistakenly shut down all 30 engines when a fire was detected in the first stage less than 70 seconds after liftoff. Three more failures would follow before the Soviet government would abandon their manned-Moon program.

The historic photos on the right shows 1) the N1 under construction with the 30-engine first stage, 2) the Soviet lunar lander and 3) two N1 rockets on pads at the Baikonur Cosmodrome (also known as Tyuratam) in Kazakhstan. The five stage rockets stood approximately 340 feet high.



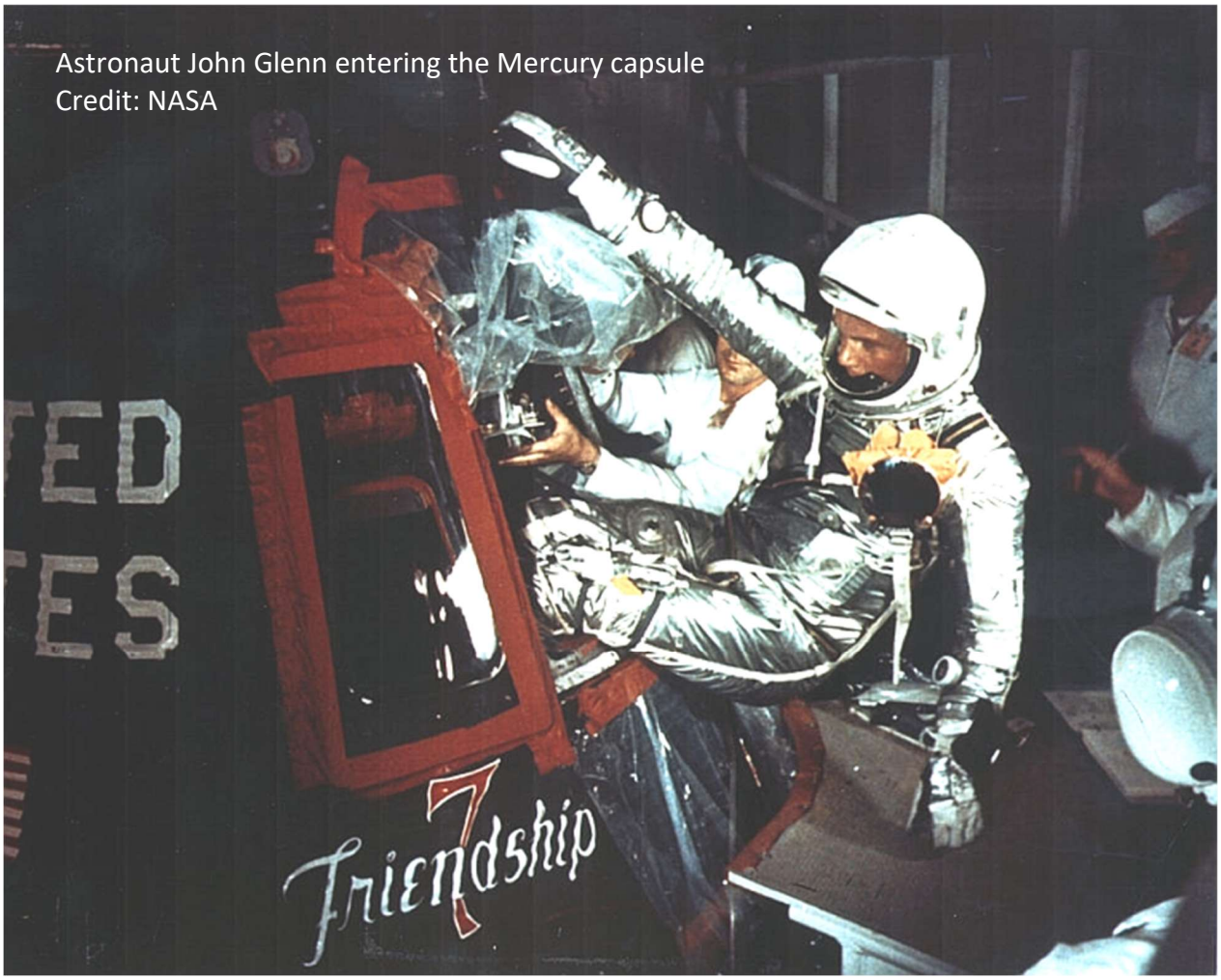




John Glenn and the Flight of Freedom 7

On the morning of February 20, 1962, John Glenn became the first American to orbit the Earth aboard a Mercury space capsule that Glenn named Friendship 7. Originally scheduled for the previous December, the launch was delayed by several technical and mechanical issues, including a fuel leak, and by weather.

Glenn served with the Marine Corps prior to being selected by NASA for its manned spaceflight program. As a fighter pilot, he flew 59 combat missions in the South Pacific during World War II. Following service in the Korean War (baseball Hall of Fame legend Ted Williams was one of his wingmen), he set a speed record for a transcontinental flight on July 16, 1957 when he flew a Vought F8U Crusader from California non-stop to New York in 3 hours 23 minutes in a test of a new Pratt & Whitney engine (it did require 3 mid-air refuelings).



Astronaut John Glenn entering the Mercury capsule
Credit: NASA

Glenn's trip around the Earth lasted 4 hours and 55 minutes and 23 seconds, completing 3 orbits before splashing down in the Atlantic Ocean southeast of Bermuda. While a public relations success, the flight was not without problems, the most serious of which was an indication that the capsule's heat shield had come loose and its landing bag deployed. Not knowing whether it was a faulty indicator, mission control asked Glenn to leave the retro-pack on during reentry. (The retro-pack consisted of three small rockets that were used to slow the spacecraft down. It was attached to the spacecraft by three straps that extended over the heat shield.) Fortunately, the indicator was

faulty and the flaming debris that Glenn saw streaming by his window during reentry was from the retro-pack and not the heat shield.

John Glenn would not return to space for another 36 years. In 1998, at the age of 77, Glenn joined the crew of the space shuttle Discovery for a nine-day mission. He was the oldest person to fly in space. John Glenn died Thursday, Dec. 8, 2016 at the age of 95. He was the last of the original Mercury 7 astronauts selected by NASA in 1958 for the agency's fledgling manned spaceflight program.

Sunrise and Sunset (from New Milford, CT)

Sun	Sunrise	Sunset
February 1st (EST)	07:06	17:08
February 15th	06:49	17:26
February 28th	06:31	17:42

Astronomical and Historical Events

1st New Moon
1st Aten Asteroid *367943 Duende* closest approach to Earth (1.602 AU)
1st History: loss of the space shuttle Columbia upon reentry (2003)
2nd History: Soviet space station Salyut 4 reenters the Earth's atmosphere (1977)
3rd History: Apollo 14, with astronauts Alan Shepard, Stuart Roosa and Edgar Mitchell, lands in the Moon's Fra Mauro region; 3rd manned Moon landing (1971)
3rd History: Soviet spacecraft Luna 9 becomes first spacecraft to soft land on the Moon (1966)
4th Amor Asteroid *5863 Tara* closest approach to Earth (2.190 AU)
4th History: launch of Lunar Orbiter 3; photographed potential Apollo landing sites (1967)
4th History: Clyde Tombaugh born (1906); discovered the dwarf planet Pluto in 1930
5th Closest approach of Main Belt Asteroid *253587 Cloutier*, discovered by the McCarthy Observatory on 2003 October 14
5th Apollo Asteroid 2018 CA1 near-Earth flyby (0.025 AU)
5th History: flyby of Venus by the Mariner 10 spacecraft on its way to Mercury; first U.S. spacecraft to photograph Venus, first to use gravity of one planet to propel itself to another, and the first spacecraft to visit Mercury (1974)
6th History: Soviet space station Salyut 7 reenters Earth's atmosphere (1991)
6th History: Apollo 14 astronaut Alan Shepard attempts to golf on the Moon (1971)
7th History: launch of the Stardust spacecraft for a rendezvous with Comet Wild 2 (1999)
7th History: Bruce McCandless makes first untethered spacewalk using a jet-powered backpack (1984)
7th History: Astronomical Society of the Pacific founded (1889)
7th History: William Huggins born, pioneered work in astronomical spectroscopy and first to differentiate nebular and galactic spectra (1824)
8th First Quarter Moon
8th Aten Asteroid 2007 UY1 near-Earth flyby (0.036 AU)
8th Apollo Asteroid *6489 Golevka* closest approach to Earth (2.380 AU)

Astronomical and Historical Events

8th History: Allende Meteorite fall (meteorites from the fall were the first extraterrestrial rocks analyzed in the NASA Lunar Receiving Laboratory which had just been completed in September of 1967 to support the Apollo program) (1969)
8th History: discovery of the SAU 094 Mars meteorite in Sayh al Uhaymir, Oman; one of the largest Mars meteorites recovered and the only one with a documented strewn field (2001)
8th History: discovery of GRV 99027 Martian Meteorite on the ice sheet near the Grove Mountain region of Antarctica; the 9.97-gram meteorite was later characterized as a shergottite (2000)
8th History: flyby of Jupiter by the Ulysses spacecraft on its way to study the polar regions of the Sun (1992)
8th History: return of Skylab III crew (astronauts Gerald Carr, William Pogue and Edward Gibson) to Earth after a 3 month stay on the space station (1974)
8th History: Jules Verne born, author and futurist (1828)
9th United Arab Emirates Hope (Al-Amal) spacecraft enters orbit around Mars (2021)
9th History: launch of the ESA's Solar Orbiter on an Atlas 5 rocket from the Cape Canaveral Air Force Station, Florida
10th Moon at apogee (furthest distance from Earth)
10th China's Tianwen-1 enters orbit around Mars (2021)
10th History: flyby of Venus by the Galileo spacecraft (for a gravity assist) on its way to Jupiter; the encounter provided the first views of mid-level clouds on Venus and confirmed the presence of lightning (1990)
10th History: flyby of Mars by the Soviet Mars 4 spacecraft; failed to enter orbit but did detect night-side ionosphere (1974)
10th History: MIT, using Millstone Hill radar in Westford, MA, bounces radar off Venus (1958)
10th History: discovery of Asteroid 624 *Hecktor*, largest Jupiter Trojan, by August Kopff (1907)
11th Kuiper Belt Object *420356 Praamzius* at Opposition (42.039 AU)
11th History: launch of NASA's Solar Dynamics Observatory from Cape Canaveral, Florida; the first mission in the space agency's "Living with a Star" program; five-year mission to study the Sun's energy and its influence on space weather (2010)
11th History: launch of the space shuttle Discovery (STS-82), second Hubble Space Telescope servicing mission; **shuttle tire** on display at the Observatory is from this mission (1997)
11th History: launch of first Japanese satellite: Oshumi (1970)
12th McCarthy Observatory – Second Saturday Stars
12th Binary Aten Asteroid 152931 (2000 EA107) closest approach to Earth (1.426 AU)
12th Amor Asteroid *9172 Abhramu* closest approach to Earth (2.657 AU)
12th History: landing of the Near-Earth Asteroid Rendezvous (NEAR) – Shoemaker spacecraft on the asteroid *Eros* (2001)
12th History: Soviet spacecraft Mars 5 enters orbit around Mars, providing information on surface temperatures, CO_2 concentrations, and detecting a thin ozone layer and water vapor concentrations near the Tharsis region (1974)
12th History: Sikhote Alin meteorite fall in Russia, one of the largest modern falls at 28 tons (1947)
13th Amor Asteroid *3691 Bede* closest approach to Earth (0.756 AU)

Astronomical and Historical Events (continued)

14th Aten Asteroid 2020 DF near-Earth flyby (0.031 AU)
14th Atira Asteroid 2021 BS1 closest approach to Earth (0.972 AU)
14th Amor Asteroid *6050 Miwablock* closest approach to Earth (1.730 AU)
14th History: flyby of Comet *Tempel 1* by the Stardust spacecraft (2011)
14th History: NEAR-Shoemaker enters orbit around *Eros*, one of the largest of the near-Earth asteroids (2000)
14th History: Voyager 1 points its camera back towards the Sun and takes a family portrait, capturing six planets (Venus, Earth, Jupiter, Saturn, Uranus and Neptune) from a distance of approximately 4 billion miles; Mercury was too close to the Sun to be seen and Mars was lost in the scattered sunlight (1990)
14th History: launch of the Solar Maximum Mission (1980) to study the Sun during the peak of the solar cycle; a malfunction less than a year later cut the mission short. However, the satellite was recovered and repaired by the Space Shuttle Challenger in April 1984; operated successfully until burning up in the Earth's atmosphere in December 1989
14th History: launch of Luna 20, Soviet Moon sample return (1972)
14th History: launch of Syncom 1, the first geosynchronous satellite (1963)
15th Atira Asteroid 418265 (2008 EA32) closest approach to Earth (0.760 AU)
15th Amor Asteroid *2061 Anza* closest approach to Earth (1.892 AU)
15th Binary Kuiper Belt Object *79360 Sila-Nunam* at Opposition (42.443 AU)
15th Scheduled launch of a Russian Progress cargo-carrying spacecraft from the Baikonur Cosmodrome, Kazakhstan to the International Space Station
15th History: meteor explodes over the Russian city of Chelyabinsk causing hundreds of minor injuries (2013)
15th History: discovery of Centaur Object *Chariklo* by Jim Scotti (1997)
15th History: flyby of the Moon by the Hiten spacecraft; Earth orbiting satellite designed by the Japanese Space Agency to test technologies for lunar and planetary missions (1992)
15th History: Pioneer 10 becomes the first spacecraft to traverse the Main Asteroid Belt (1973)
15th History: Galileo Galilei born (1564)
16th Full Moon
16th Mercury at its Greatest Western Elongation – separation from the Sun in the morning sky (26°)
16th History: Gerard Kuiper discovers Uranus' moon *Miranda* (1948)
17th Amor Asteroid *1916 Boreas* closest approach to Earth (2.226 AU)
17th History: discovery of the Plutino *90482 Orcus* with its large moon, Vanth, by American astronomers Michael Brown of Caltech, Chad Trujillo of the Gemini Observatory, and David Rabinowitz of Yale University (2004)
17th History: Ann Harch discovers *Dactyl*, the first natural satellite of an asteroid (*Ida*) discovered from Galileo Images (1994)
17th History: launch of Ranger 8; lunar impact mission (1965)
17th History: launch of NEAR spacecraft, asteroid orbiter/lander; first of NASA's Discovery missions and the first mission to go into orbit around an asteroid (1996)
17th History: launch of Vanguard 2; designed to measure cloud-cover distribution over Earth (1959)
18th Aten Asteroid 2018 CW2 near-Earth flyby (0.006 AU)
18th Aten Asteroid 2020 CX1 near-Earth flyby (0.019 AU)

Astronomical and Historical Events (continued)

18th Kuiper Belt Object 543354 (2014 AN55) at Opposition (44.390 AU)
18th History: landing of the Mars 2020 Perseverance rover in Jezero crater (2021)
18th History: Mike Brown and Jean-Luc Margot's discovery of *Romulus*, the larger of two moon that orbit Asteroid 87 *Sylvia* (2001)
18th History: American astronomer Clyde Tombaugh discovers Pluto (1930)
19th Scheduled launch of a Northrop Grumman Cygnus cargo freighter from Wallops Islands, Virginia to the International Space Station
19th History: Nicolas Copernicus born (1473)
20th Atira Asteroid 164294 (2004 XZ130) closest approach to Earth (0.566 AU)
20th Kuiper Belt Object 2021 DR15 at Opposition (88.608 AU)
20th History: Clementine spacecraft enters lunar orbit and starts photographic survey; joint project between the Strategic Defense Initiative Organization and NASA, first of a new class of small spacecraft to enable long-duration, deep space missions at low cost using lightweight satellite technology (1994)
20th History: launch of the core module of the Soviet space station Mir (1986)
20th History: launch of Mercury-Atlas 6 and Friendship 7 with astronaut John Glenn; first American in orbit (1962)
21st Apollo Asteroid *471926 Jormungandr* closest approach to Earth (0.734 AU)
21st Amor Asteroid *2202 Pele* closest approach to Earth (1.704 AU)
21st History: launch of Israel's SpaceIL, privately-funded, lunar lander aboard a SpaceX Falcon 9 rocket from the Cape Canaveral Air Force Station, Florida
21st History: Soviet moon rocket (N-1) explodes during first test flight (1969)
22nd Apollo Asteroid 455176 (1999 VF22) near-Earth flyby (0.036 AU)
22nd Apollo Asteroid *1620 Geographos* closest approach to Earth (0.541 AU
22nd Kuiper Belt Object 55565 (2002 AW197) at Opposition (44.168 AU)
22nd History: launch of Viking, Sweden's first satellite (1986)
22nd History: launch of Soviet spacecraft Kosmos 110, with dogs Veterok and Ugolyok (1966)
22nd History: Max Wolf discovers asteroid 588 *Achilles* – the first Trojan asteroid (1906)
23rd Last Quarter Moon
23rd Apollo Asteroid 2017 CX1 near-Earth flyby (0.038 AU)
23rd History: Supernova 1987A detected in the Large Magellanic Cloud (1987)
24th Apollo Asteroid *161989 Cacus* closest approach to Earth (0.385 AU)
24th Atira Asteroid 2014 FO47 closest approach to Earth (0.819 AU)
24th Kuiper Belt Object 55565 (2002 AW197) at Opposition (44.054 AU)
24th Kuiper Belt Object 148209 (2000 CR105) at Opposition (62.711 AU)
24th History: launch of the Space Shuttle Discovery (STS-133) on its final mission. The shuttle delivered space parts and critical components to the ISS (2011)
24th History: launch of Mariner 6; Mars flyby mission returned images showing the south polar cap as being composed predominantly of carbon dioxide; refined estimates of the mass, radius and shape of Mars (1969)
24th History: Jocelyn Bell announces discovery of rapidly rotating radio sources, later determined to emanate from neutron stars or pulsars (1968)
24th History: launch of Bumper WAC, first two-stage liquid-propellant rocket and the first human-made object to achieve hypersonic speeds (1949)
25th Parker Solar Probe's 11th Perihelion - coming within 5.3 million miles (8.5 million km) of the solar surface

Astronomical and Historical Events (continued)

25th Centaur Object *32532 Thereus* at Opposition (11.027 AU)
25th Kuiper Belt Object 308193 (2005 CB79) at Opposition (37.652 AU)
25th History: flyby of Mars by the Rosetta spacecraft (2007)
25th History: Soviet spacecraft Luna 20 returns lunar soil sample (30 grams) to Earth (1972)
26th Moon at perigee (closest distance from Earth)
26th Binary Asteroid *163693 Atira* closest approach to Earth (0.612 AU)
26th Amor Asteroid *332 Davidaguilar* closest approach to Earth (0.949 AU)
26th Amor Asteroid *1036 Ganymed* closest approach to Earth (3.108 AU)
26th History: launch of the first Saturn 1B rocket booster (1966)
26th History: original crew of Gemini 9, Elliot See and Charles Bassett killed in plane crash at the McDonnell Aircraft building in St. Louis (1966)
27th History: discovery of Jupiter's moon Herse was by Brett J. Gladman, John J. Kavelaars, Jean-Marc Petit, and Lynne Allen (2003)
28th Aten Asteroid 2020 UO4 near-Earth flyby (0.047 AU)
28th History: flyby of Jupiter by the New Horizons spacecraft bound for Pluto (2007)
28th History: launch of Discoverer 1; first of a series of satellites which were part of the Corona reconnaissance satellite program and first satellite launched into polar orbit (1959)

Commonly Used Terms

- Apollo: a group of near-Earth asteroids whose orbits also cross Earth's orbit; Apollo asteroids spend most of their time outside Earth orbit.
- Aten: a group of near-Earth asteroids whose orbits also cross Earth's orbit, but unlike Apollos, Atens spend most of their time inside Earth orbit.
- Atira: a group of near-Earth asteroids whose orbits are entirely within Earth's orbit
- Centaur: icy planetesimals with characteristics of both asteroids and comets
- Kuiper Belt: region of the solar system beyond the orbit of Neptune (30 AUs to 50 AUs) with a vast population of small bodies orbiting the Sun
- Opposition: celestial bodies on opposite sides of the sky, typically as viewed from Earth
- Plutino: an asteroid-sized body that orbits the Sun in a 2:3 resonance with Neptune
- Trojan: asteroids orbiting in the 4th and 5th Lagrange points (leading and trailing) of major planets in the Solar System

References on Distances

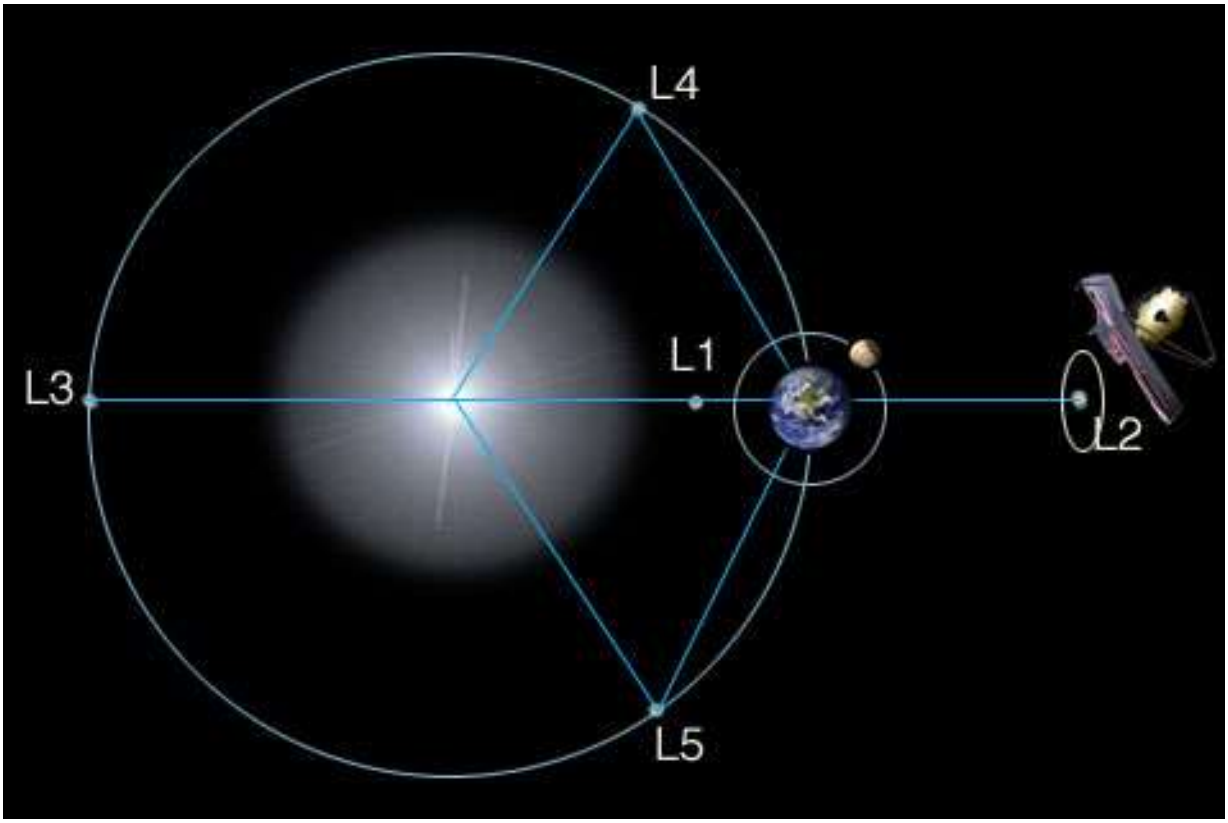
- the apparent width of the Moon (and Sun) is approximately one-half a degree (½°), less than the width of your little finger at arm's length which covers approximately one degree (1°); three fingers span approximately five degrees (5°)
- 1 astronomical unit (AU) is the distance from the Sun to the Earth or approximately 93 million miles

International Space Station and Starlink Satellites

Visit www.heavens-above.com for the times of visibility and detailed star charts for viewing the International Space Station and the bright flares from Iridium satellites.

Lagrange Points

Five locations discovered by mathematician Joseph Lagrange where the gravitational forces of the Sun and Earth (or other large body) and the orbital motion of the spacecraft are balanced, allowing the spacecraft to hover or orbit around the point with minimal expenditure of energy. The L2 point (and location of the Webb telescope) is located 1 million miles (1.5 million km) beyond the Earth (as viewed from the Sun).



James Webb Space Telescope

https://webb.nasa.gov/index.html

Solar Activity

For the latest on what's happening on the Sun and the current forecast for flares and aurora, check out www.spaceweather.com

NASA's Global Climate Change Resource

Vital Signs of the Planet: https://climate.nasa.gov/

Mars – Mission Websites

Mars 2020 (Perseverance rover): https://mars.nasa.gov/mars2020/

Mars Helicopter (Ingenuity): https://mars.nasa.gov/technology/helicopter/

Mars Science Laboratory (Curiosity rover): https://mars.nasa.gov/msl/home/

Mars InSight (lander): https://mars.nasa.gov/insight/

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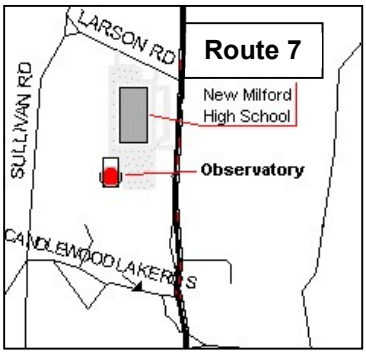

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