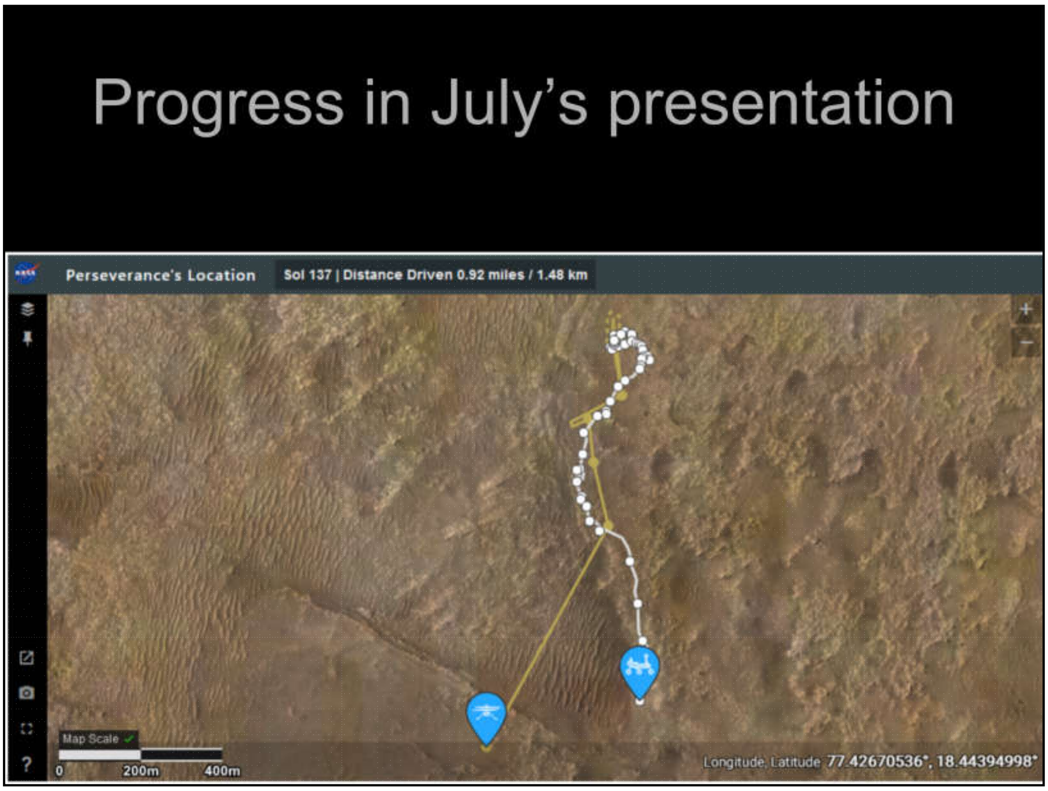
Mars Exploration Update

Tom Heisey
Solar System Ambassador
Sep 16, 2021

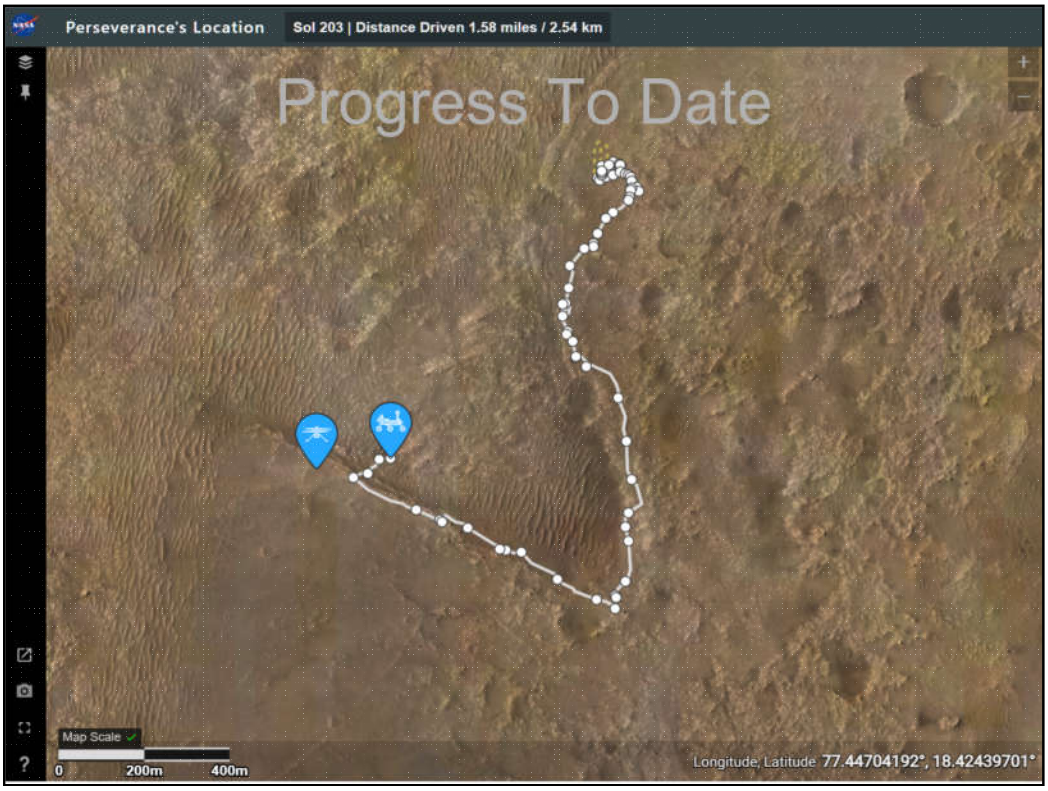
Images from NASA web sites and materials unless otherwise noted

Ingenuity helicopter technology demo paired with the Perseverance.



https://mars.nasa.gov/mars2020/mission/where-is-the-rover/

This is the image I shared at the July meeting showing the progress of Ingenuity and Perseverence up to Flight 9.

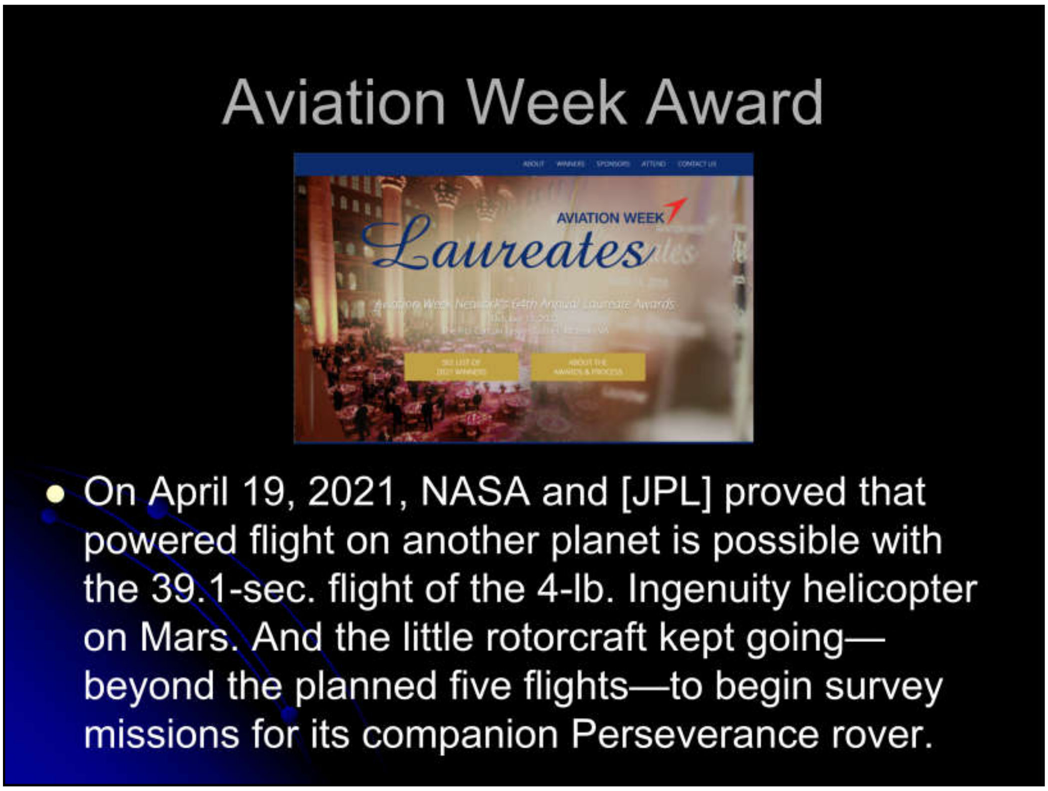


https://mars.nasa.gov/mars2020/mission/where-is-the-rover/

This was the current location of Ingenuity and Perseverance at the time of the meeting.

https://www.spacefoundation.org/2021/06/09/space-foundation-selects-nasa-jpl-ingenuity-mars-helicopter-flight-team-to-receive-2021-john-l-jack-swigert-jr-award-for-space-exploration/

COLORADO SPRINGS, Colo. — June 9, 2021 — Space Foundation, a nonprofit advocate organization founded in 1983 for the global space ecosystem, is proud to announce the NASA Jet Propulsion Laboratory (JPL) Mars Ingenuity Flight Team as the recipient of the 2021 John L. “Jack” Swigert Jr. Award for Space Exploration... In announcing this year’s recipient, Space Foundation CEO Tom Zelibor shared, “As a multiple-time recipient of the John L. ‘Jack’ Swigert Jr. Award for Space Exploration, the NASA JPL team continues to raise the bar when it comes to extraordinary accomplishments in the realm of space exploration and discovery. The work of this most unique team has changed history not just on this planet, but it has also truly accomplished a feat beyond compare.”The award will be presented Aug. 23, 2021, during the 36th Space Symposium’s opening ceremony, to be held at The Broadmoor in Colorado Springs. The ceremony will also be simulcast online as part of Space Symposium’s all-new virtual experience.



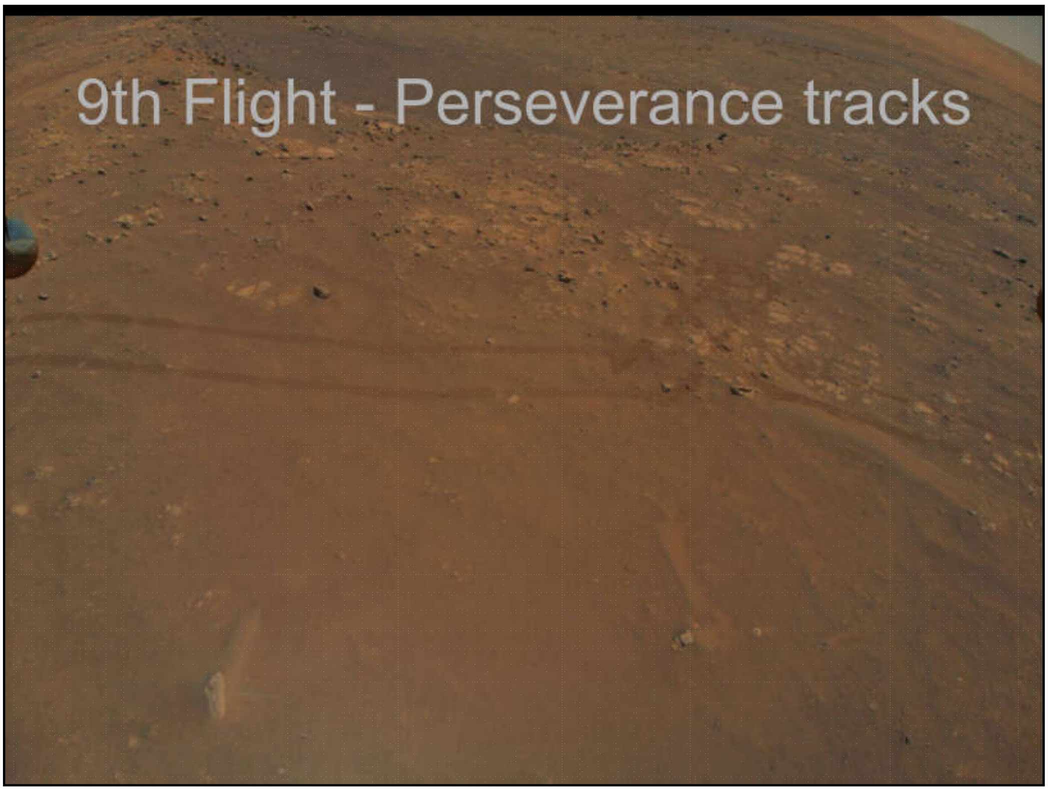
https://laureates.aviationweek.com/en/home.html

Since its inception, Aviation Week Network's Laureate Awards have honored extraordinary achievements in aerospace. Innovators that represent the values and vision of the global aerospace community have changed the way people work, and move through the world.

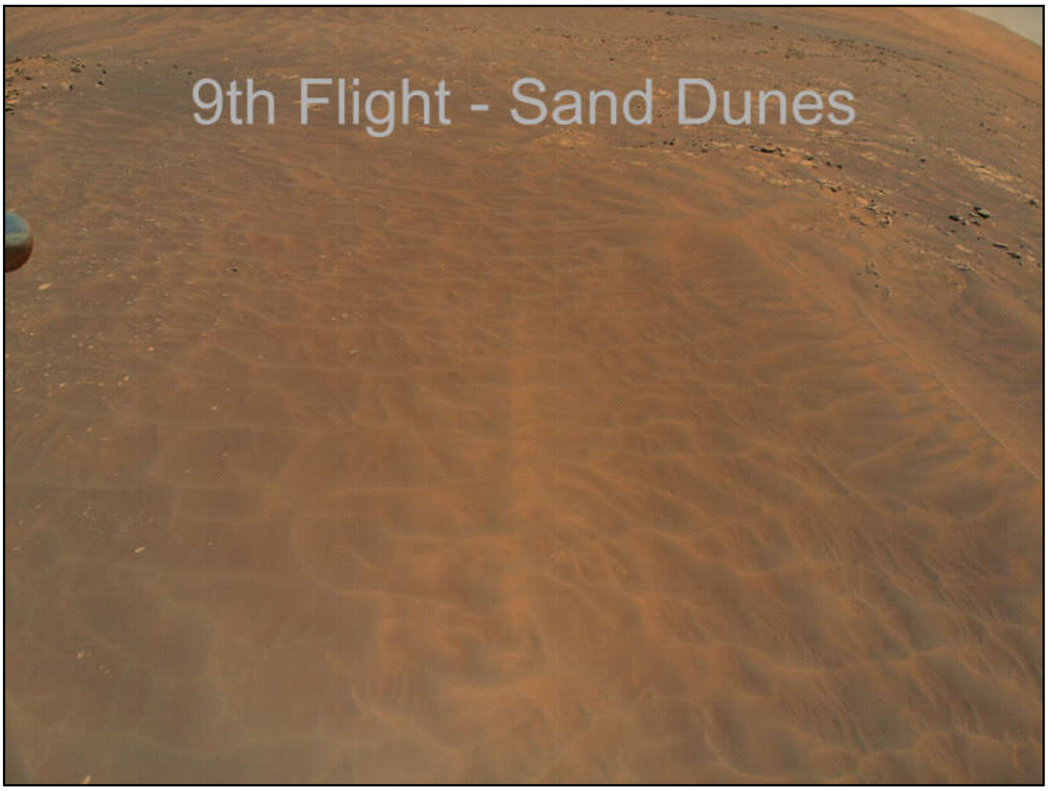
https://laureates.aviationweek.com/en/winners/2021-winners.html

NASA/JPL Mars Ingenuity

On April 19, 2021, NASA and its Jet Propulsion Laboratory proved that powered flight on another planet is possible with the 39.1-sec. flight of the 4-lb. Ingenuity helicopter on Mars. And the little rotorcraft kept going—beyond the planned five flights—to begin survey missions for its companion Perseverance rover.



https://mars.nasa.gov/news/8987/nasas-mars-helicopter-reveals-intriguing-terrain-for-rover-team/

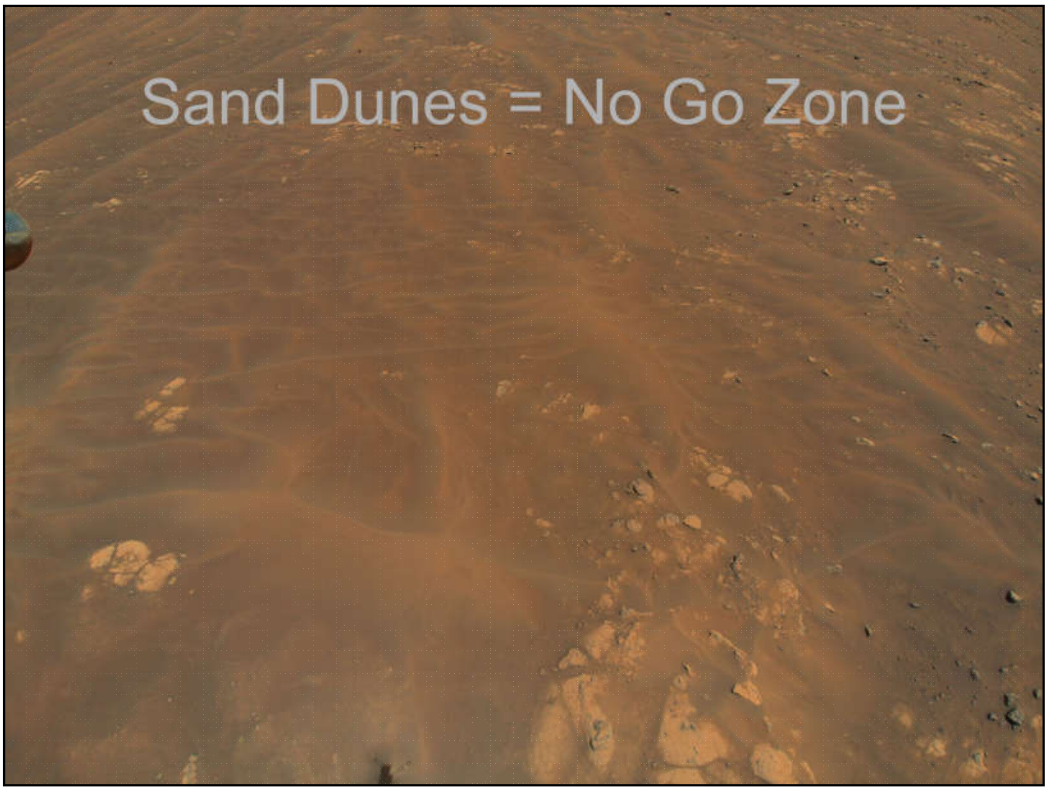


https://mars.nasa.gov/news/8987/nasas-mars-helicopter-reveals-intriguing-terrain-for-rover-team/

Sand dunes like the ones in this image keep rover drivers like JPL's Olivier Toupet awake at night: Knee- or waist-high, they could easily cause the two-ton rover to get stuck. After landing in February, Perseverance scientists asked whether it was possible to make a beeline across this terrain; Toupet's answer was a hard no.

"Sand is a big concern," said Toupet, who leads the team of mobility experts that plans Perseverance's drives. "If we drive downhill into a dune, we could embed ourselves into it and not be able to get back out."

Toupet is also the lead for Perseverance's newly tested AutoNav feature, which uses artificial intelligence algorithms to drive the rover autonomously over greater distances than could be achieved otherwise. While good at avoiding rocks and other hazards, AutoNav can't detect sand, so human drivers still need to define "keep-out zones" around areas that could entrap the rover.



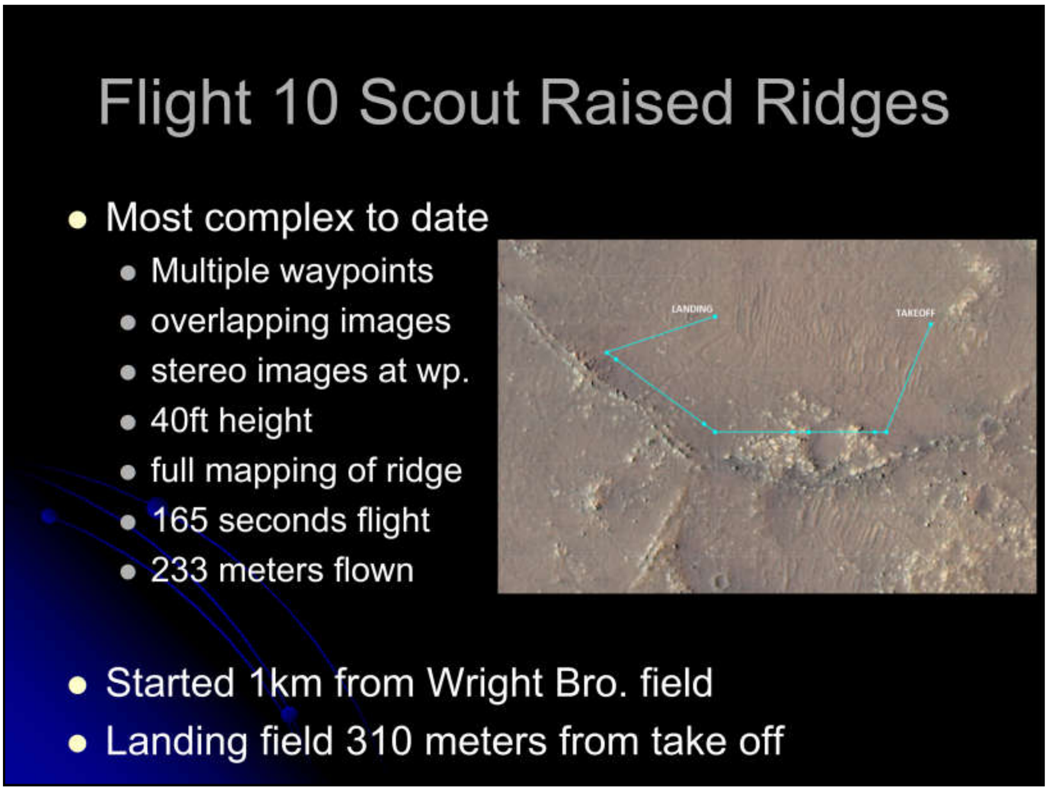
https://mars.nasa.gov/news/8987/nasas-mars-helicopter-reveals-intriguing-terrain-for-rover-team/

NASA's Ingenuity Mars Helicopter flew over these sand dunes and rocks during its ninth flight, on July 5, 2021. While the agency's Perseverance Mars can't risk getting stuck in this sand, scientists are still able to learn about this region by studying it from Ingenuity's images. Credits: NASA/JPL-Caltech. Full image and caption ›

Without Ingenuity, visible in silhouette at the bottom of this next image, Perseverance's scientists would never get to see this section of Séítah so clearly: It's too sandy for Perseverance to visit. The unique view offers enough detail to inspect these rocks and get a better understanding of this area of Jezero Crater.

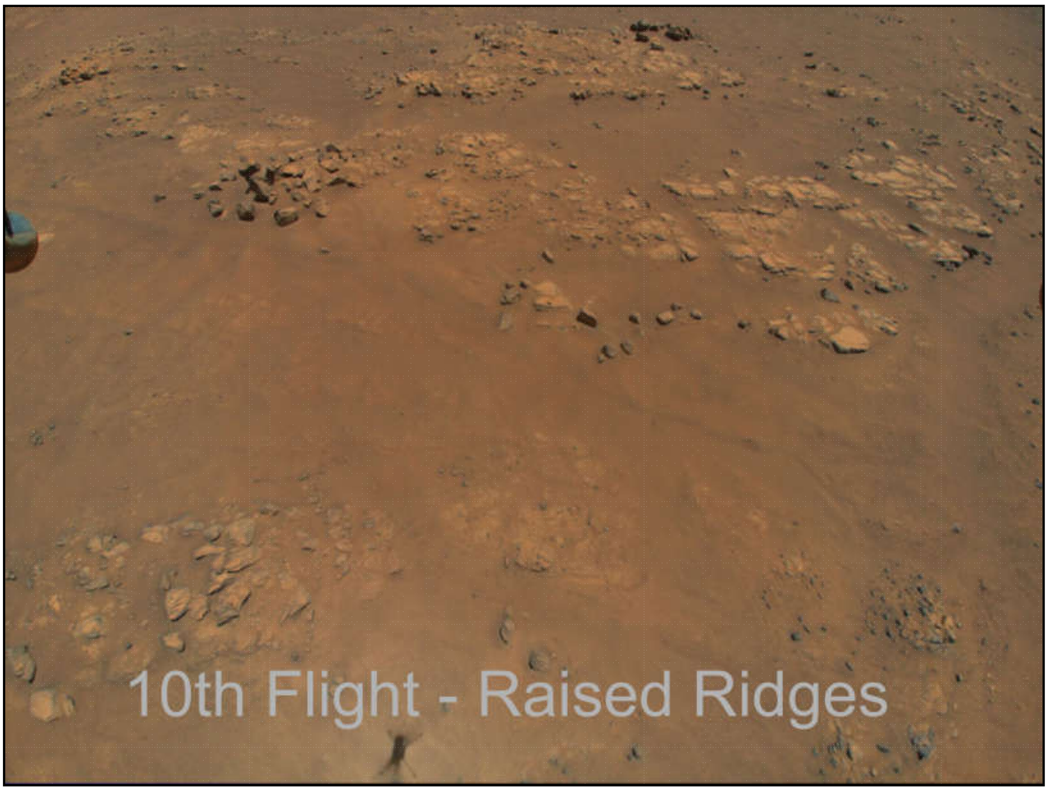
As the rover works its way around the dune field, it may make what the team calls a "toe dip" into some scientifically compelling spots with interesting bedrock. While Toupet and his team wouldn't attempt a toe dip here, the recent images from Ingenuity will allow them to plan potential toe-dip paths in other regions along the route of Perseverance's first science campaign.

"The helicopter is an extremely valuable asset for rover planning because it provides high-resolution imagery of the terrain we want to drive through," said Toupet. "We can better assess the size of the dunes and where bedrock is poking out. That's great information for us; it helps identify which areas may be



https://mars.nasa.gov/technology/helicopter/status/316/aerial-scouting-of-raised-ridges-for-ingenuitys-flight-10/

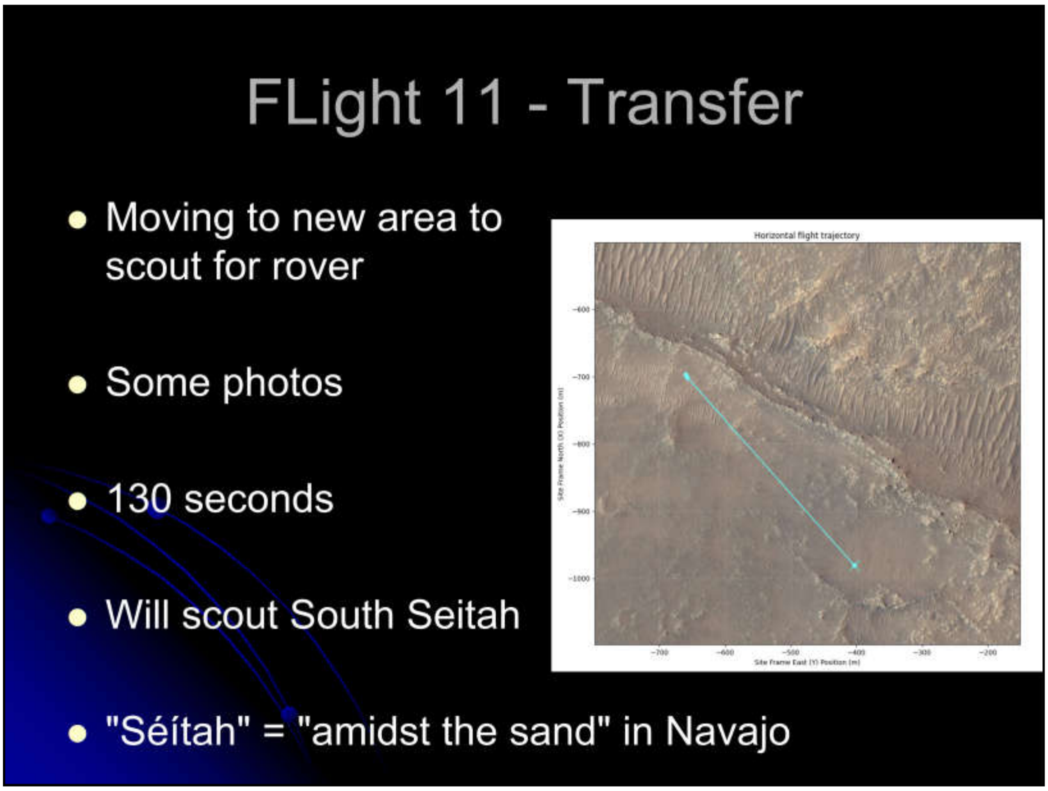
These multiple waypoints included some angling of the helicopter to get a slightly angled of the ridges for a better height perspective. The flight was higher than others and was an amazing accomplishment.



https://mars.nasa.gov/news/8987/nasas-mars-helicopter-reveals-intriguing-terrain-for-rover-team/

Future target for Perseverance

Ingenuity (its shadow is visible at the bottom of this image) offered a high-resolution glimpse of rock features nicknamed “Raised Ridges.” They belong to a fracture system, which often serve as pathways for fluid to flow underground. Here in Jezero Crater, a lake existed billions of years ago. Spying the ridges in images from Mars orbiters, scientists have wondered whether water might have flowed through these fractures at some point, dissolving minerals that could help feed ancient microbial colonies. That would make them a prime location to look for signs of ancient life – and perhaps to drill a sample. The samples Perseverance takes will eventually be deposited on Mars for a future mission that would take them to Earth for in-depth analysis. “Our current plan is to visit Raised Ridges and investigate it close up,” Williford said. “The helicopter’s images are by far better in resolution than the orbital ones we were using. Studying these will allow us to ensure that visiting these ridges is important to the team.”



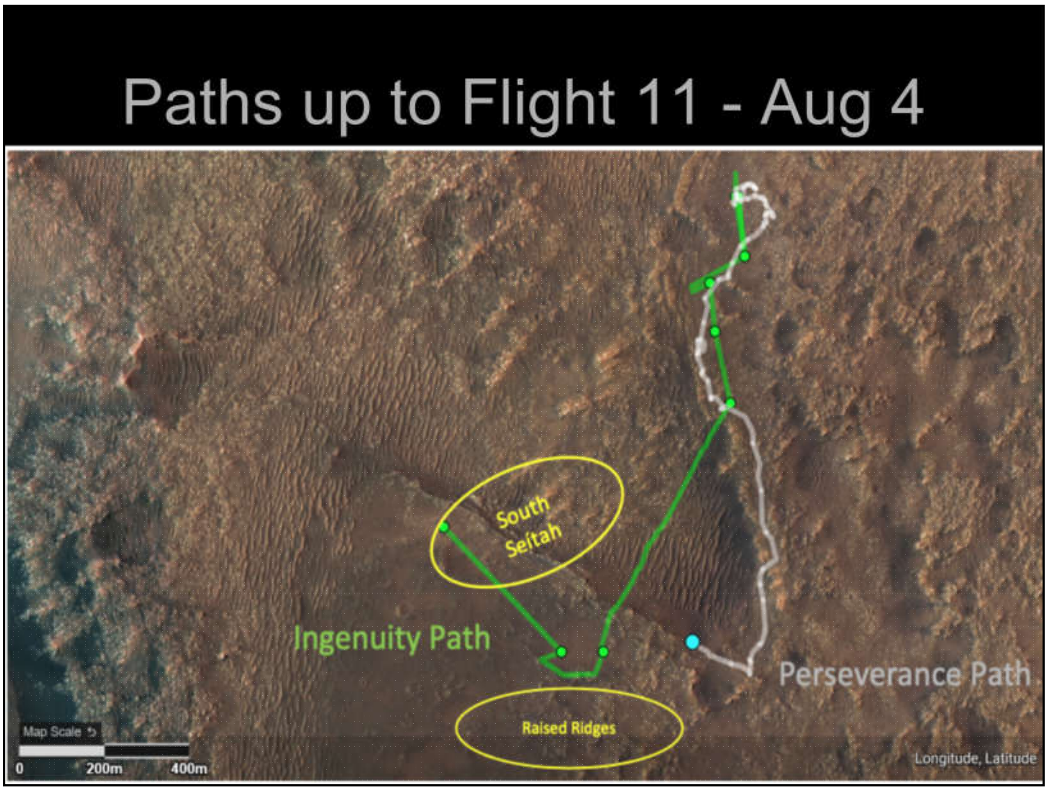
https://mars.nasa.gov/technology/helicopter/status/318/north-by-northwest-for-ingenuitys-11th-flight/

We’re heading northwest for the 11th flight of NASA’s Ingenuity Mars Helicopter, which will happen no earlier than Wednesday night, Aug. 4. The mission profile is designed to stay ahead of the rover – supporting its future science goals in the “South Séítah” region, where it will be able to gather aerial imagery in support of future Perseverance Mars rover surface operations in the area.

Here is how we plan to do it: On whatever day the flight takes place, we will start at 12:30 p.m. local Mars time (on Aug. 4, this would be 9:47 p.m. PDT/Aug. 5, 12:47 a.m. EDT). Ingenuity wakes up from its slumber and begins a pre-programmed series of preflight checks. Three minutes later, we’re off – literally – climbing to a height of 39 feet (12 meters), then heading downrange at a speed of 11 mph (5 meters per second).

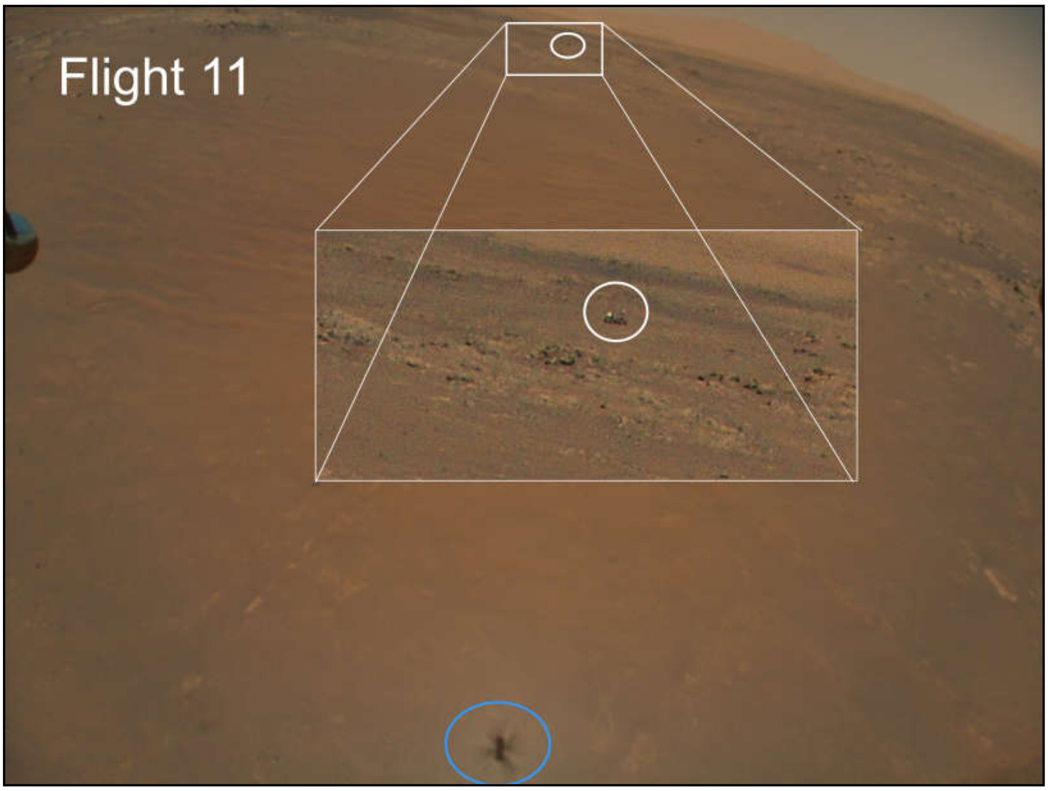
And while Flight 11 is primarily intended as a transfer flight – moving the helicopter from one place to the other - we’re not letting the opportunity go to waste to take a few images along the way. Ingenuity’s color camera will take multiple photos en route, and then at the end of the flight, near our new airfield, we’ll take two images to make a 3D stereo pair. Flight 11 – from takeoff to landing –- should take about 130 seconds.

As requested by the Perseverance science team, our new base of operations, which is approximately 385 meters (1260 feet) to the northwest of Ingenuity’s current location, will become the staging area for at least one reconnaissance flight of the geologically intriguing South Séítah area.



https://mars.nasa.gov/resources/26134/ground-tracks-of-nasas-perseverance-and-ingenuity/

his annotated image depicts the ground tracks of NASA's Perseverance rover (white) and Ingenuity Mars Helicopter (green) since arriving on Mars on Feb. 18, 2021. The green dots represent the locations of the helicopter’s airfields during the 11 flights it has made between April 19 and Aug. 4. The lower yellow ellipse highlights the "Raised Ridges" geologic feature that Ingenuity reconnoitered during Flight 10. The upper yellow ellipse depicts the "South Séítah" region, which Ingenuity is scheduled to fly over during its 12th sortie.



https://mars.nasa.gov/resources/26128/seitah-from-39-feet-up/

Flight 11

Figure 1 shows the "South Séítah" region of Jezero Crater, captured by NASA’s Ingenuity Mars Helicopter during its 11th flight on Aug. 4, 2021. At the bottom center of the image is Ingenuity’s shadow. Above it, toward the top of the frame – just beyond the dune field and right of center – is the Perseverance rover (the bright white dot).

https://mars.nasa.gov/technology/helicopter/status/321/better-by-the-dozen-ingenuity-takes-on-flight-12/

Thanks to its newly enabled AutoNav capability, Perseverance is quickly moving northwest across the southern ridge of Séítah (white path) and will meet Ingenuity in the coming days.

The plan is as follows: Ingenuity will climb to an altitude of 10 meters and fly approximately 235 meters east-northeast toward the area of interest in Séítah. Once there, the helicopter will make a 5-meter “sidestep” in order to get side-by-side images of the surface terrain suitable to construct a stereo, or 3D, image. Then, while keeping the camera in the same direction, Ingenuity will backtrack, returning to the same area from where it took off. Over the course of the flight, Ingenuity will capture 10 color images that we hope will help the Perseverance science team determine which of all the boulders, rocky outcrops and other geologic features in South Séítah may be worthy of further scrutiny by the rover.

Ingenuity’s navigation system – which was originally intended to support a short technology demonstration – works on the assumption that it is flying across flat (or nearly flat) terrain. Deviations from this assumption can introduce errors that can lead both to temporary excursions in roll and pitch (tilting back and forth in an oscillating pattern), as well as long-term errors in the helicopter’s knowledge of its position.

https://mars.nasa.gov/resources/26177/flight-12-view-of-south-seitah/

August 25, 2021

This image sand dunes, boulders, and rocky outcrops of the “South Séítah” region of Mars’ Jezero Crater was captured by NASA’s Ingenuity Mars Helicopter during its 12th flight, on Aug. 16, 2021. Ingenuity’s shadow is visible in the lower third of the image, just right of center. A portion of the foot on one of the helicopter’s four landing legs is visible along the upper-left edge of the image. In the upper-right corner (arching toward the top middle of the image) is a ridgeline that is of interest to the Perseverance rover science team.

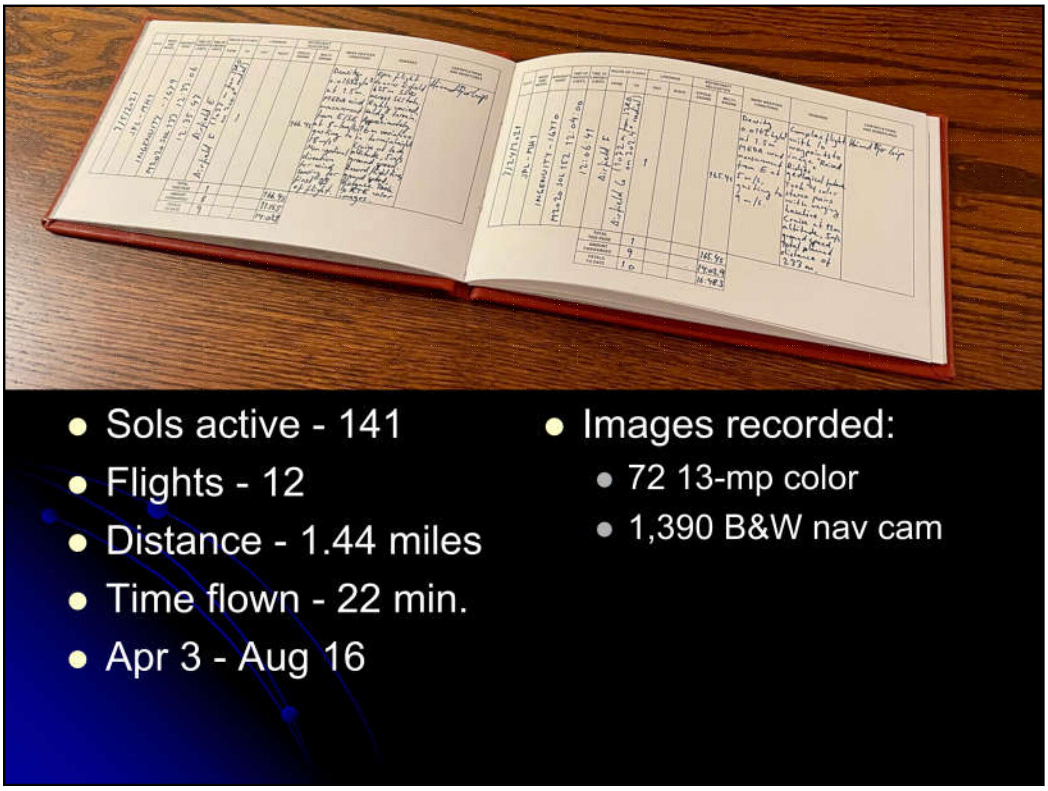
Taken from an altitude of 33 feet (10 meters), the image is one of 10 collected during the flight at the request of the Mars Perseverance rover science team, which is considering whether to explore the location further.

https://mars.nasa.gov/news/9021/my-favorite-martian-image-helicopter-sees-potential-rover-road-ahead/

Prior to Ingenuity's latest flight, the majority of what the Perseverance science team knew of the southern portion of the Seítah feature came from orbiter images... They used the rotorcraft's images to look for signs of layered, sedimentary rock that could have been deposited in water, intriguing rocky outcrops accessible to the rover, and safe routes the rover could take into and back out of the area.

"From a science perspective, these images of South Seítah are the most valuable Ingenuity has taken to date," said Farley, who's based at Caltech. "And part of their value may be in what they are not showing. Sedimentary layers in rocks are not readily apparent in the image, and there may be areas that could be difficult to negotiate with the rover. There is work to do by our science and rover driving teams to understand better how to respond to the new data."

"What this image may be saying is, we don't need to drive further west to obtain the best geologic variety of this first science campaign," said Farley. "If we decide to make the trip to South Seítah, we've got some valuable intel on what we'll encounter. And if the decision is to stick around 'Artuby Ridge,' the rover's current location, we'll have saved valuable time. It's a win-win."



https://mars.nasa.gov/resources/26133/ingenuity-logbook-entries/

https://mars.nasa.gov/technology/helicopter/status/329/lucky-13-ingenuity-to-get-lower-for-more-detailed-images-during-next-flight/

Along with those listed below, we've taken 72 13-megapixel color images and 1,390 black-and-white navigation camera images. We're looking forward to add to these numbers and learning more about that ridgeline when "lucky 13" is in the books.

Since Deployment

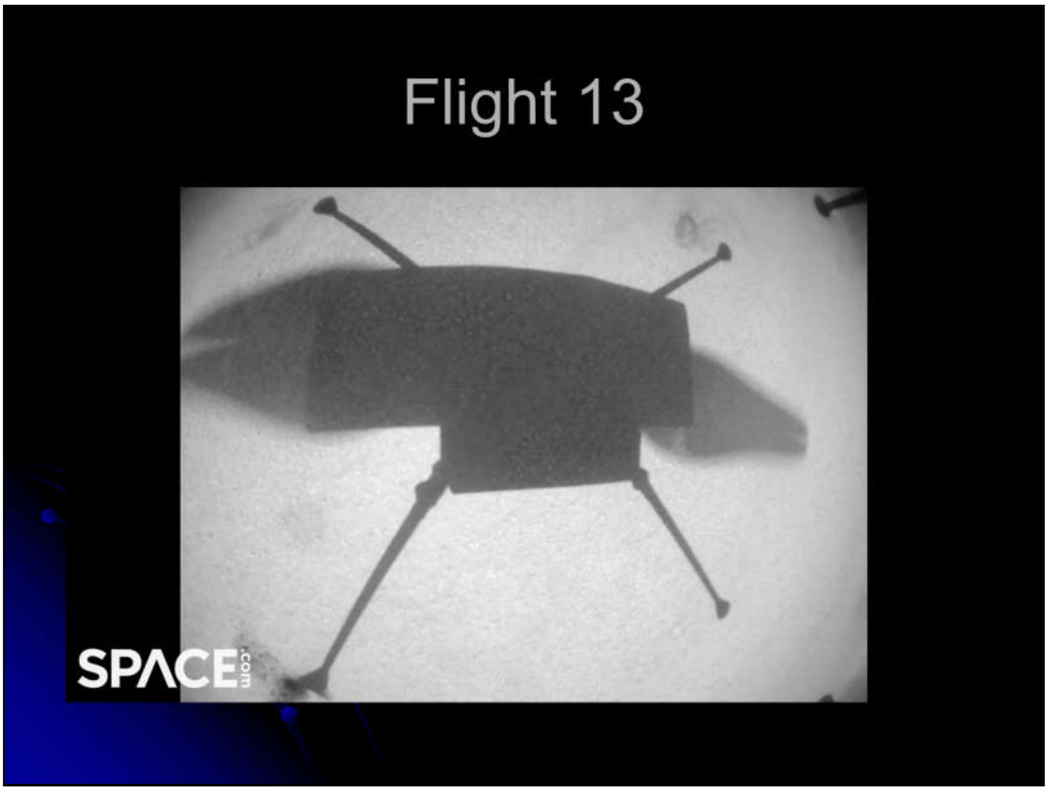
(April 3, 2021/Sol 43)	In Tech Demo		In Ops Demo	% Above Tech Demo
Sols Achieved	141	31	111	358%
Num. Flights 12	5	7	140%	
Distance Flown (m)	2671 m (~1.44 nmiles)		2172 m	435%
Time Flown (s)	1308 s (21 min 48 s)		396 s	912 s
230%				

Flight 13 - Scout Seitah 2

- Closer view of ridge
- Target for rover?
- Looking southwest
  - F-12 was northeast
  - Combined 3D view
- 690 feet, 161 seconds, 10 pictures

https://mars.nasa.gov/technology/helicopter/status/329/lucky-13-ingenuity-to-get-lower-for-more-detailed-images-during-next-flight/

https://spacenity.com/see-ingenuitys-13th-flight-on-mars-in-its-entirety



https://spacenity.com/see-ingenuitys-13th-flight-on-mars-in-its-entirety (Movie)

NASA Ingenuity Helicopter traveled at 7.3 mph (3.3 m/s) "taking images pointing southwest of the South Seítah region" and flew 26 feet (8 meters) above the surface of Mars on Sept. 4, 2021, according to NASA's Jet Propulsion Laboratory. Full Story: https://www.space.com/mars-helicopter-ingenuity-13th-flight

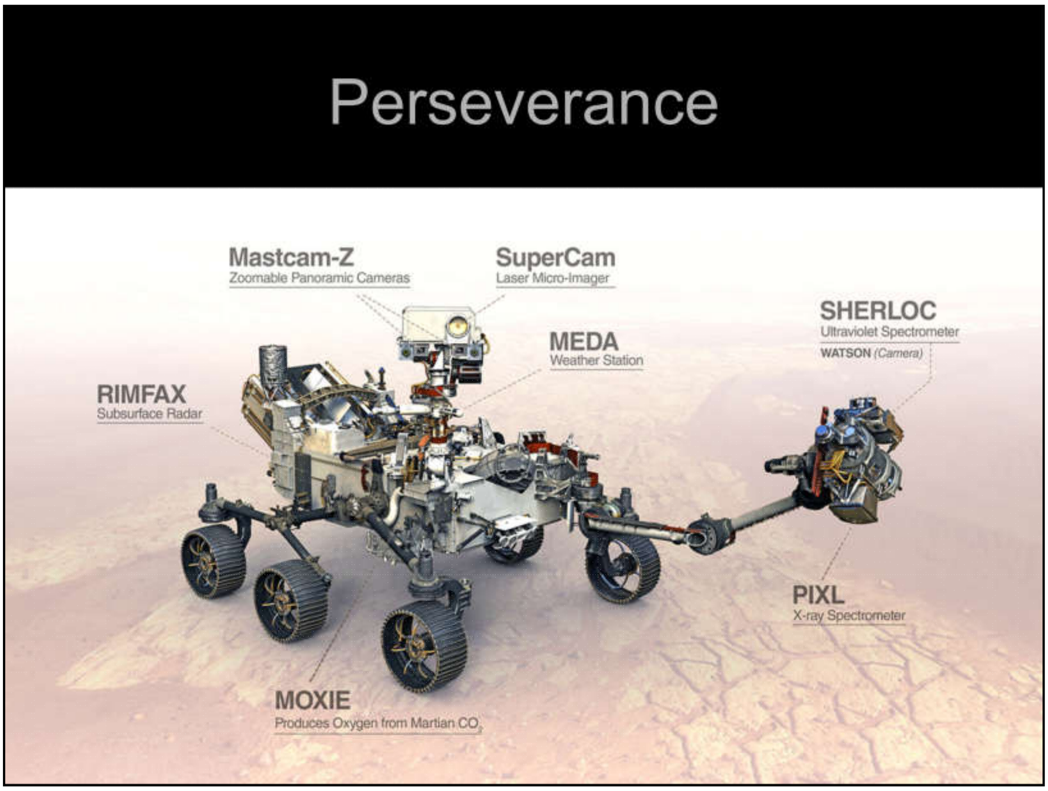
Credit: Space.com | imagery & audio courtesy: NASA/JPL-Caltech | produced & edited by Steve Spaleta (http://www.twitter.com/stevespaleta)

Flight Log

Flight	Sol	Date	Horizontal Distance		Max. Altitude		Max. Groundspeed		Duration	Route of Flight	
			m	ft	m	ft	m/s	mph	seconds	From	To
1	58	April 19, 2021	0	0	3	~10	0	0	39.1	Wright Brothers Field	
2	61	April 22, 2021	4	~13	5	~16	0.5	~1	51.9		
3	64	April 25, 2021	100	~328	5	~16	2	~4.5	80.3		
4	69	April 30, 2021	266	~873	5	~16	3.5	~8	116.9		
5	76	May 7, 2021	129	~423	10	~33	2	~4.5	108.2	Wright Brothers Field	Airfield B
6	91	May 22, 2021	215	~705	10	~33	4	~9	139.9	Airfield B	Airfield C
7	107	June 8, 2021	106	~348	10	~33	4	~9	62.8	Airfield C	Airfield D
8	120	June 21, 2021	160	~525	10	~33	4	~9	77.4	Airfield D	Airfield E
9	133	July 5, 2021	625	~2051	10	~33	5	~11	166.4	Airfield E	Airfield F
10	152	July 24, 2021	233	~764	12	~39	5	~11	165.4	Airfield F	Airfield G
11	163	Aug. 4, 2021	383	~1257	12	~39	5	~11	130.9	Airfield G	Airfield H
12	174	Aug. 16, 2021	450	~1476	10	~33	4.3	~10	169.5	Airfield H	Airfield H
13	193	Sep. 4, 2021	210	~689	8	~26	3.3	~7	160.5	Airfield H	Airfield H

Total - 1,469.2 seconds or 24.5 minutes

- 2,881meters or 2.88km or 1.79 miles



https://mars.nasa.gov/mars2020/spacecraft/instruments/

Mastcam-Z - stereoscopic and panoramic camera with zoom capability

MEDA - weather station - temp, wind speed & direction pressure, humidity, dust size/shape

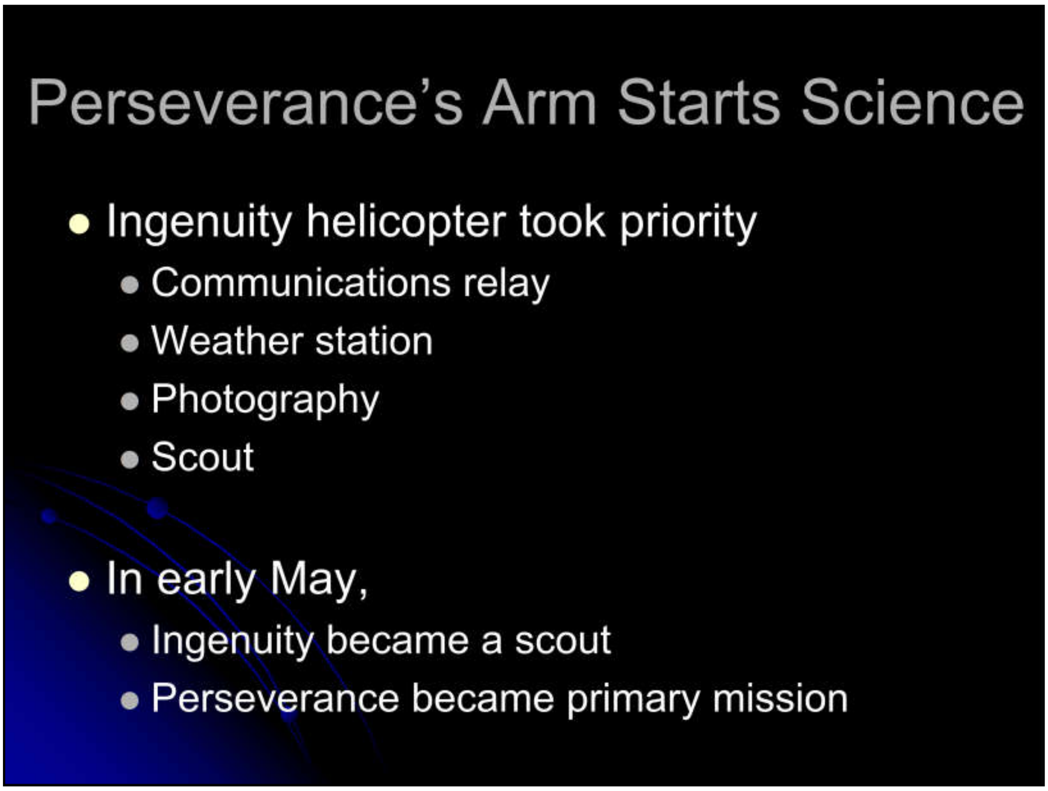
MOXIE - Produce oxygen from Martian CO2

PIXL - Xray fluorescence spectrometer - elemental composition of surface materials to small grain of salt

RIMFAX - ground penetrating radar

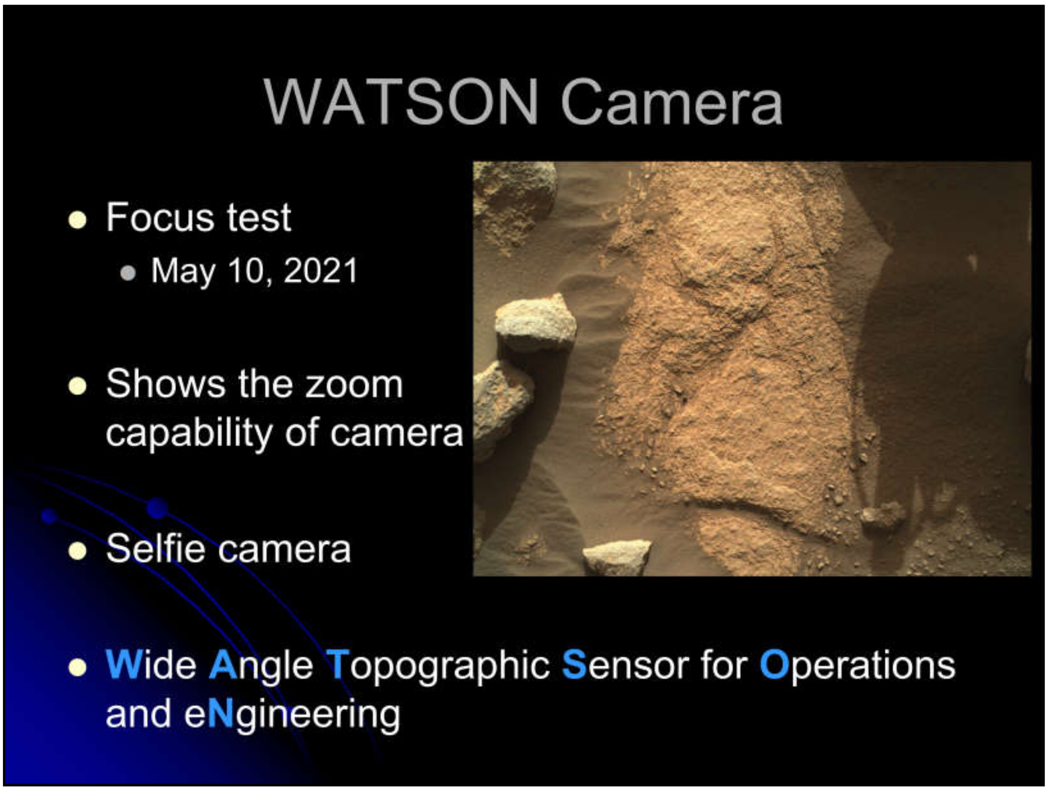
SHERLOC - UV laser and spectrometer to detect mineralogy and and organic compounds up close

SuperCam - detect mineralogy and organic compounds at a distance



https://mars.nasa.gov/news/8944/perseverances-robotic-arm-starts-conducting-science/

The rover and helicopter have switched roles. While Ingenuity was in tech demo phase, Perseverance served as base station and did very little science of its own. Now that Ingenuity has proven very useful, the helicopter serves as scout for Perseverance.



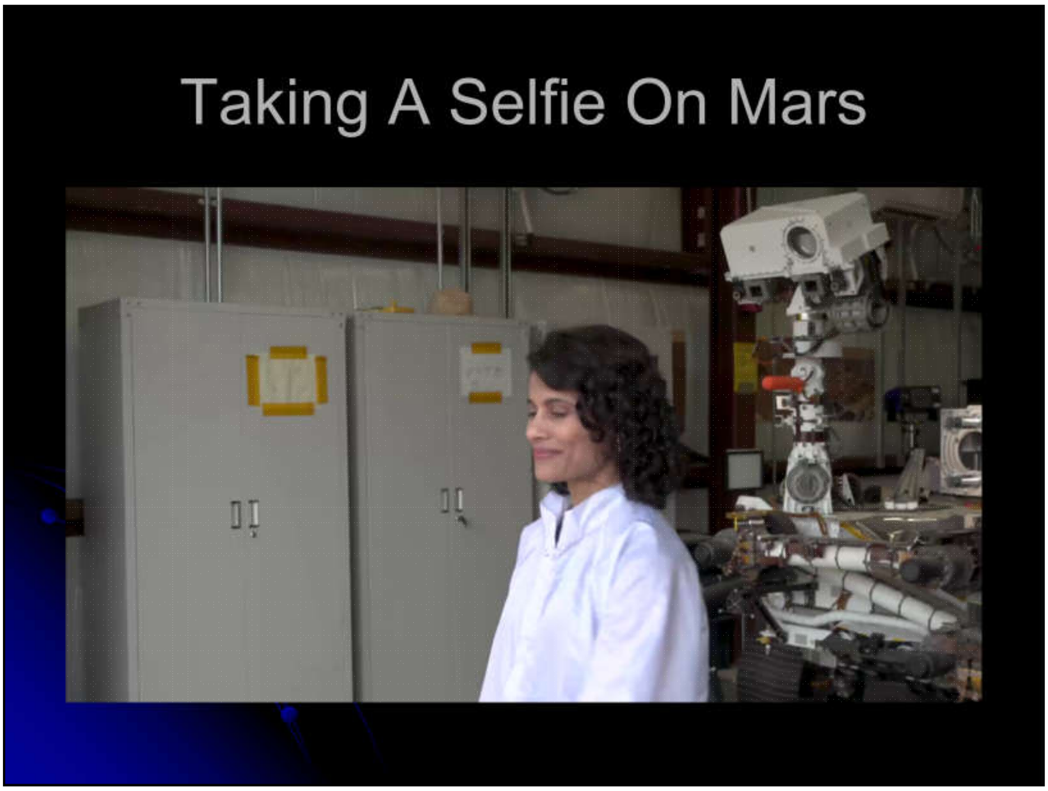
https://mars.nasa.gov/resources/25905/watson-takes-a-closer-look/ (moving Gif image)

WATSON, a color camera for taking close-up images of rock grains and surface textures.

https://mars.nasa.gov/mars2020/spacecraft/rover/cameras/#WATSON

The WATSON camera is one of the tools on the "hand" or turret at the end of Perseverance's robotic arm. It is almost identical to the MAHLI hand-lens camera on the Curiosity rover. WATSON (Wide Angle Topographic Sensor for Operations and eNgineering) captures the images that bridge the scale from the very detailed images and maps that SHERLOC collects of Martian minerals and organics to the broader scales that SuperCam and Mastcam-Z observe from the mast. WATSON provides views of the fine-scale textures and structures in Martian rocks and the rocky debris and dust that cover so much of the Martian surface. These capabilities mean WATSON not only supports SHERLOC, but also helps identify targets of interest for the other rover instruments. Since WATSON can be moved around by the robotic arm, it also provides images of instruments and rover parts. For example, it can be pointed at the oxygen-making experiment MOXIE to help monitor how much dust accumulates around the inlet that lets in Martian air for the extraction of oxygen.

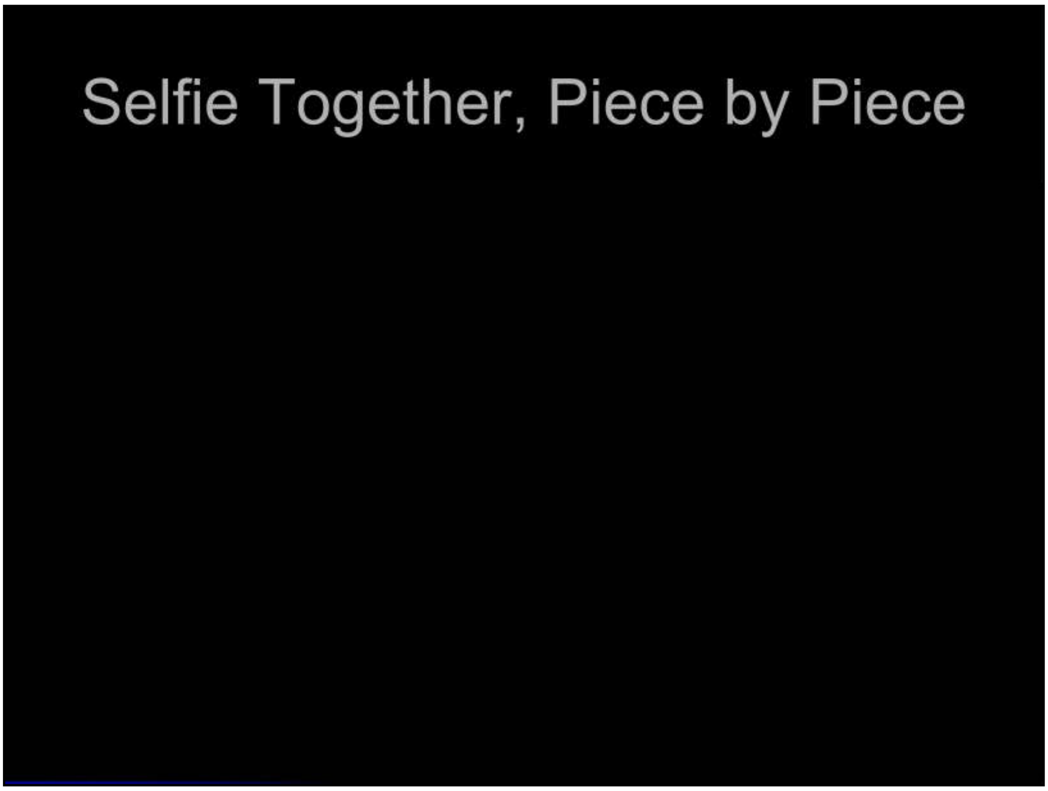
A calibration target for WATSON is attached to the front of the rover body. It contains a metric standardized bar graphic to help calibrate the instrument.



https://mars.nasa.gov/resources/26001/how-nasas-perseverance-rover-takes-a-selfie/ (movie)

Video taken by Perseverance’s navigation cameras shows the rover’s robotic arm twisting and maneuvering to take the 62 images that compose the image. The rover's entry, descent, and landing microphone captured the sound of the arm’s motors whirring during the process.

Selfies allow engineers to check wear and tear on the rover over time.



https://mars.nasa.gov/resources/26001/how-nasas-perseverance-rover-takes-a-selfie/ (Gif, showing the images stitched together.)

Selfie Together, Piece by Piece

This shows the sequence in which NASA’s Perseverance Mars rover took 62 individual images with its WATSON camera, on April 6, 2021, before they were stitched together into a single selfie.

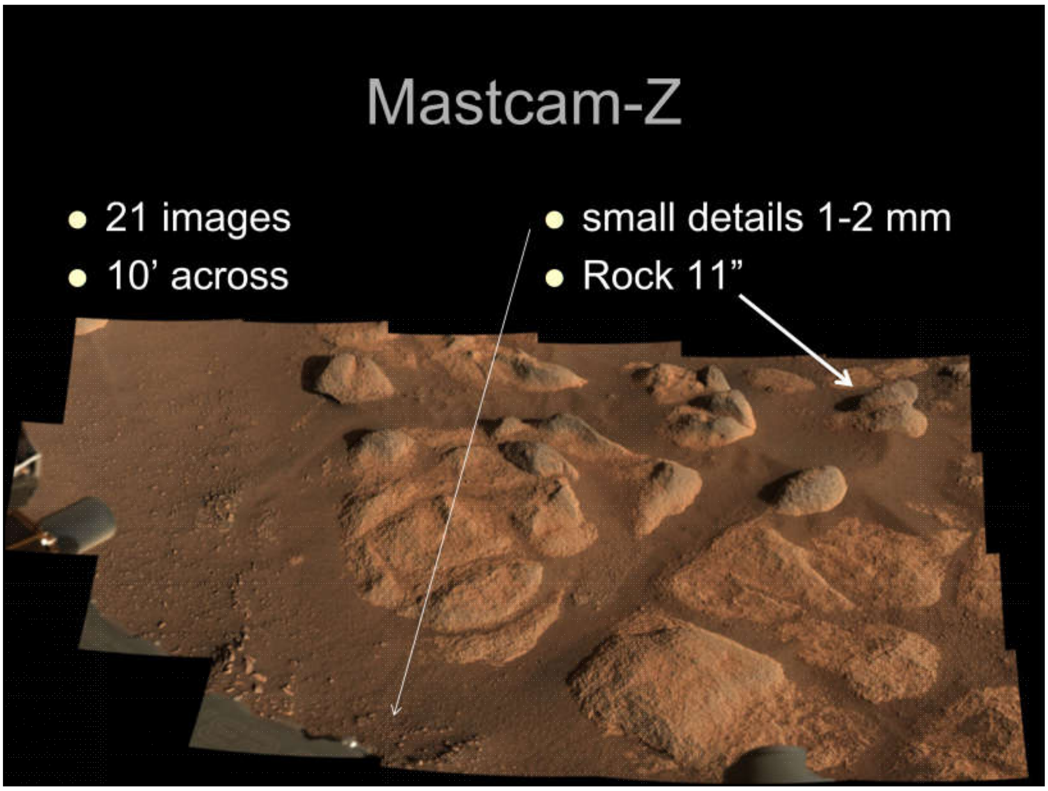
NASA’s Perseverance Mars rover took a selfie with the Ingenuity helicopter, seen here about 13 feet (3.9 meters) from the rover in this image taken April 6, 2021, the 46th Martian day, or sol, of the mission by the WATSON (Wide Angle Topographic Sensor for Operations and eNgineering) camera on the SHERLOC (Scanning Habitable Environments with Raman and Luminescence for Organics and Chemicals) instrument, located at the end of the rover's long robotic arm.

Perseverance’s selfie with Ingenuity is made up of 62 individual images stitched together once they are sent back to Earth; they were taken in sequence while the rover was looking at the helicopter, then again while it was looking at the WATSON camera. The Curiosity rover takes similar selfies using a camera on its robotic arm. Videos explaining how the rovers take their selfies can be found here.

https://mars.nasa.gov/resources/26056/perseverances-arm-over-paver-rocks/
(GIF image showing rover movement)

The robotic arm on NASA's Perseverance rover reached out to examine rocks in an area on Mars nicknamed the "Cratered Floor Fractured Rough" area in this image captured on July 10, 2021 (the 138th sol, or Martian day, of its mission). The image was taken by one of the rover's hazard cameras. An additional set of images from July 10-12 have been compiled into a GIF.

Scientists are particularly interested in the flat rocks that appear light in color (nicknamed "paver rocks"). This image was processed to enhance contrast.



https://mars.nasa.gov/resources/25903/perseverances-mastcam-z-images-intriguing-rocks/

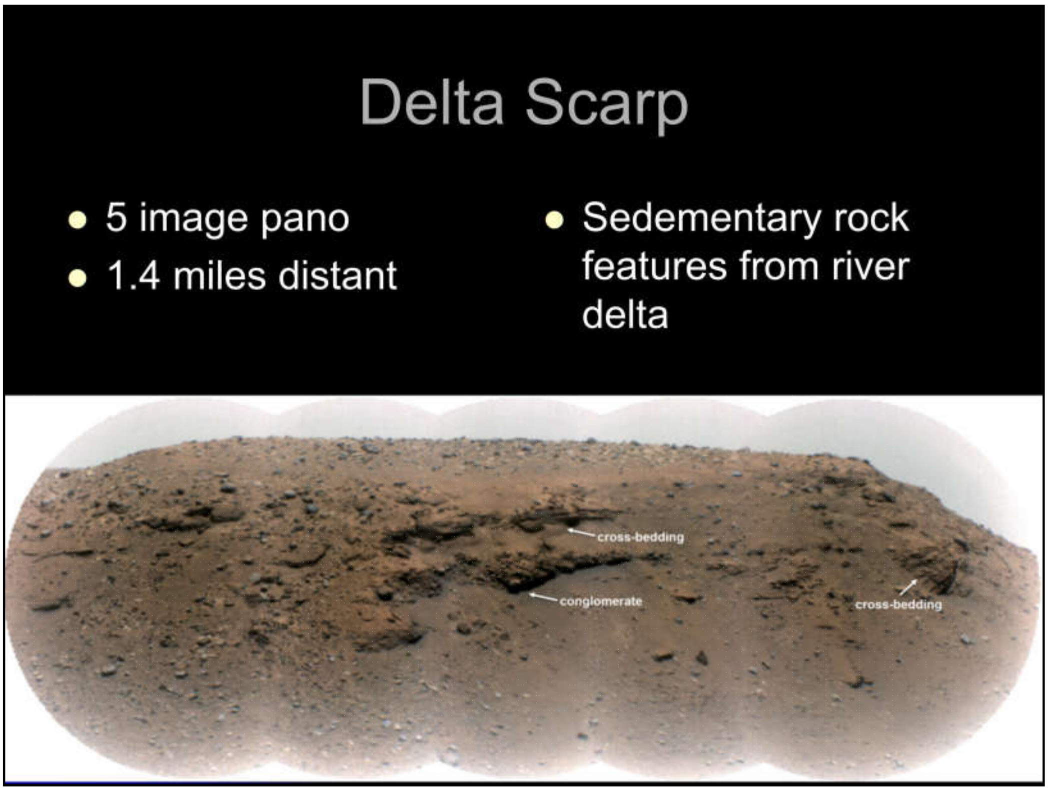
NASA’s Perseverance Mars rover viewed these rocks using its Mastcam-Z imager on April 27, 2021, the 66th Martian day, or sol, of the mission. Stitched together from 21 images, this mosaic is not white balanced; instead, it is displayed in a preliminary calibrated version of a natural-color composite, approximately simulating the colors of the scene as it would appear on Mars.

For scale, the largest piece of rock casting a shadow in the upper right part of the mosaic is about 11 inches (27 centimeters) across, and the entire scene is about 10 feet (3 meters) across. The smallest pebbles and other features that can reliably be resolved at this zoom scale are around 0.04 to 0.08 inches (1-2 millimeters) across.

https://mars.nasa.gov/resources/6010/curiositys-color-view-of-martian-dune-after-crossing-it/

This look back at a dune that NASA's Curiosity Mars rover drove across was taken by the rover's Mast Camera (Mastcam) during the 538th Martian day, or sol, of Curiosity's work on Mars (Feb. 9, 2014). The rover had driven over the dune three days earlier. For scale, the distance between the parallel wheel tracks is about 9 feet (2.7 meters). The dune is about 3 feet (1 meter) tall in the middle of its span across an opening called "Dingo Gap." This view is looking eastward.

The image has been white balanced to show what the Martian surface materials would look like if under the light of Earth's sky.

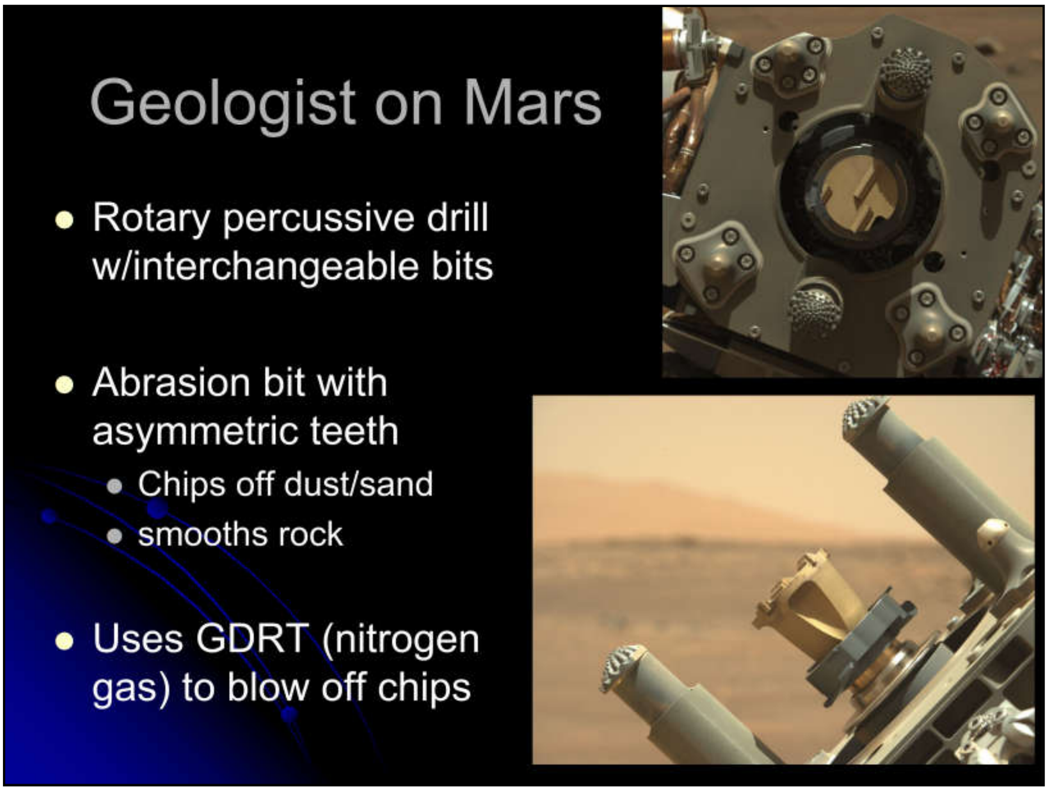


https://mars.nasa.gov/resources/25989/mars-delta-scarp-from-more-than-a-mile-away/

June 22, 2021

Composed of five images, this mosaic of the Jezero Crater's "Delta Scarp" was taken on March 17, 2021, by the Remote Microscopic Imager (RMI) camera aboard NASA's Perseverance rover from 1.4 miles (2.25 kilometers) away. Scientists believe the 377-foot-wide (115-meter-wide) escarpment is a portion of the remnants of a fan-shaped deposit of sediments that resulted from the confluence between an ancient river and an ancient lake.

An annotated version of the same image (directly below) reveals location of a conglomerate (rock composed of coarse-grained pebbles mixed with sand) and examples of crossbedding (tilted layers of sedimentary rock that can result from water passing over a loose bed of sediment).



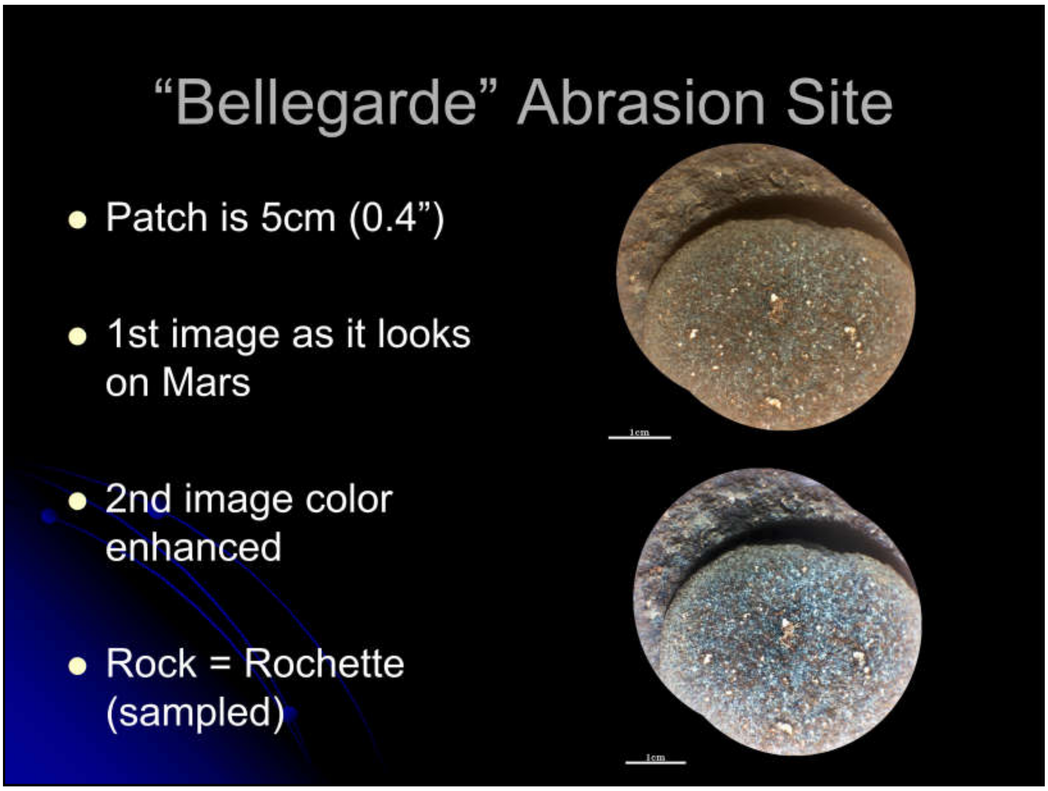
https://mars.nasa.gov/mars2020/mission/status/327/why-and-how-perseverance-abrades-rocks/

Perseverance is equipped with a rotary percussive drill and a suite of interchangeable drill bits. The sampling team had the task of being able to collect cores, collect regolith, and create abraded patches all using the same drill.

Close-up photo of Perseverance rover's drill, with its abrading bit facing the camera. The bit has a flat surface, 5 centimeters in diameter, with linear teeth for grinding rocks.

To do this, the abrading bits have an unusual tooth pattern: three parallel lines of different lengths, arranged asymmetrically. When the drill spins and hammers with an abrading bit, that tooth pattern creates crisscrossing, well distributed impacts in the rock. This chips away the surface and makes a smooth, flat patch of fresh rock about 2 inches (5 centimeters) in diameter.

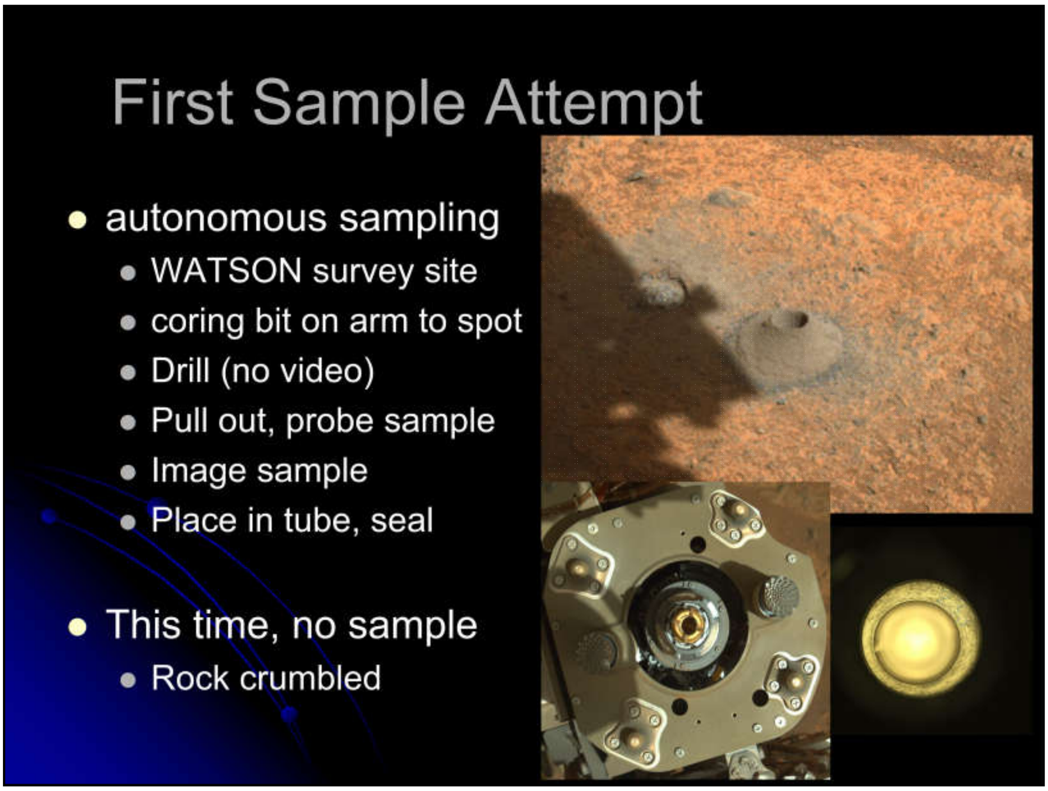
However, the newly drilled abrasion is full of cuttings - the dust generated by drilling. The cuttings hide what the scientists are interested in seeing: the color and shape of individual grains in the abrasion. Perseverance removes the cuttings using another tool on the turret called the Gaseous Dust Removal Tool (GDRT). The GDRT has a tank of nitrogen gas and uses four short puffs to blow the cuttings away and reveal the fresh rock surface underneath.



https://mars.nasa.gov/resources/26228/abrasion-patch-bellegarde/

NASA's Perseverance Mars rover used its abrasion tool to grind down the rock surface at this target, nicknamed "Bellegarde," on Aug. 29, 2021, the 188th Martian day, or sol, of the mission. The abraded patch is 0.4 inches (5 centimeters) in diameter. The mission has nicknamed the rock itself "Rochette" and acquired its first two core samples from it. The rover abrades rocks using a tool on its robotic arm before drilling them in order to clear away dust and weathering rinds, allowing other instruments to study the rocks and determine if scientists want to grab a sample of them.

This close-up image was produced by Perseverance's SuperCam instrument in natural color, as it would appear under daytime lighting conditions. A second image (Figure 2) is enhanced color. Besides imagery, SuperCam has a rock-vaporizing laser and spectrometer. By studying a rock's vapor after each laser zap, scientists can study the chemical composition of rocks from a distance.



https://mars.nasa.gov/news/9007/nasas-perseverance-team-assessing-first-mars-sampling-attempt/

Perseverance's Sampling and Caching System uses a hollow coring bit and a percussive drill at the end of its 7-foot-long (2-meter-long) robotic arm to extract samples. Telemetry from the rover indicates that during its first coring attempt, the drill and bit were engaged as planned, and post-coring, the sample tube was processed as intended.

"The sampling process is autonomous from beginning to end," said Jessica Samuels, the surface mission manager for Perseverance at NASA's Jet Propulsion Laboratory in Southern California. "One of the steps that occurs after placing a probe into the collection tube is to measure the volume of the sample. The probe did not encounter the expected resistance that would be there if a sample were inside the tube."

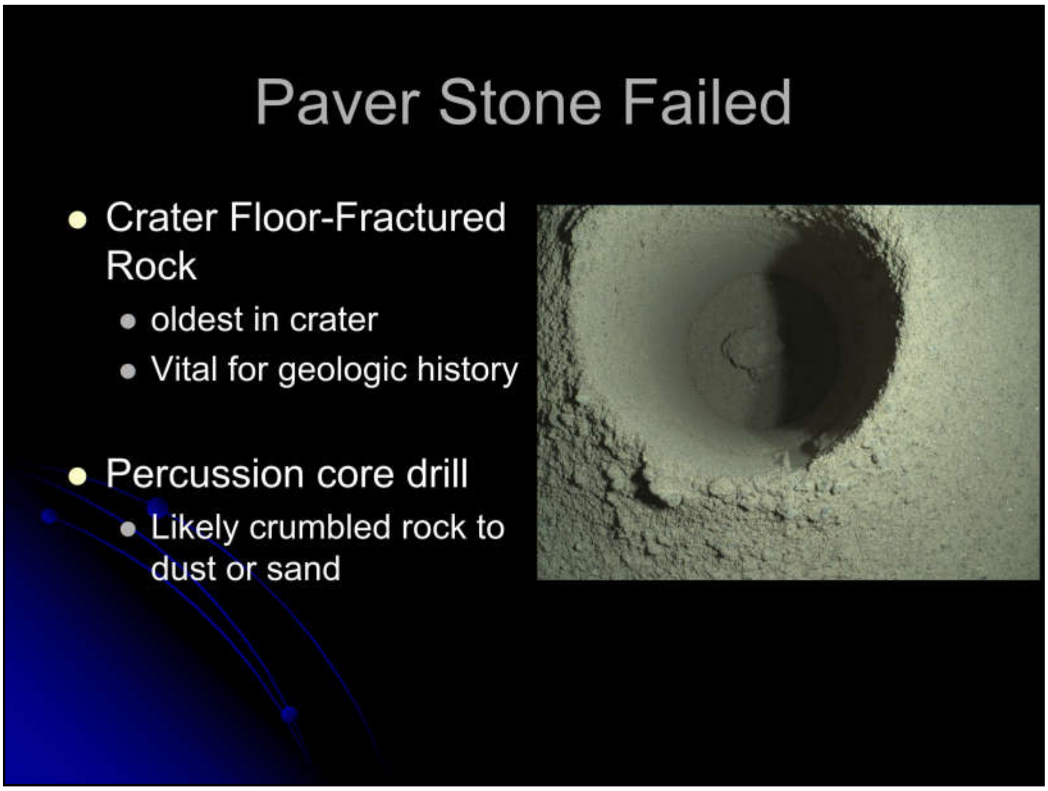


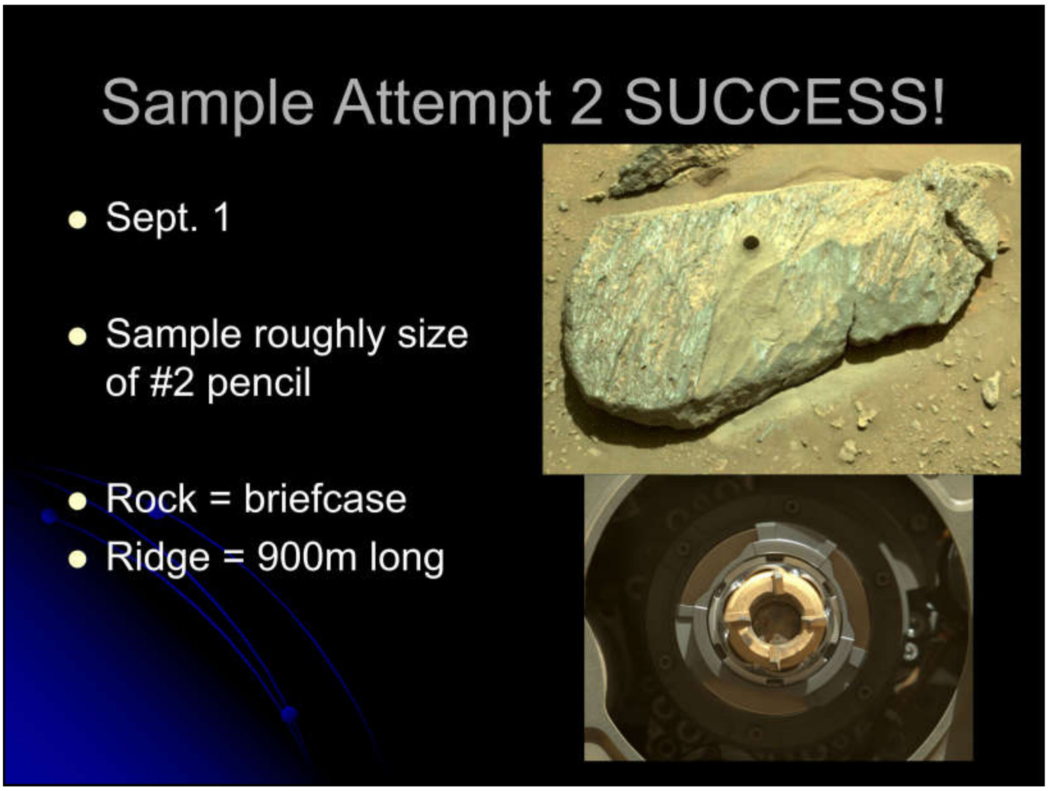
Image: https://mars.nasa.gov/resources/26125/watson-image-of-perseverances-first-borehole/

https://mars.nasa.gov/mars2020/mission/status/326/roubion-the-problematic-weathered-paver-stone-perseverance-failed-to-core/

If you are reading this blog more than likely you've heard that despite early indications of a successful core acquisition during our first attempt on Aug. 6, there was no rock in the sample tube. And that given our unsuccessful search around the rover for a "dropped core", the only reasonable interpretation is that the rock fragmented to dust or sand as we rotary-percussed into it.

Our target for this first attempt, which we called Roubion, was on one of the flat polygonal-shaped rocks that we have seen all along the rover's traverse so far. These "paver stone" rocks are an important sampling target because, among other things, this Crater Floor-Fractured Rough (CFFR) geologic unit could contain the lowest and oldest rocks we come across in the crater – important info for when we attempt to figure out the geologic history of the crater.

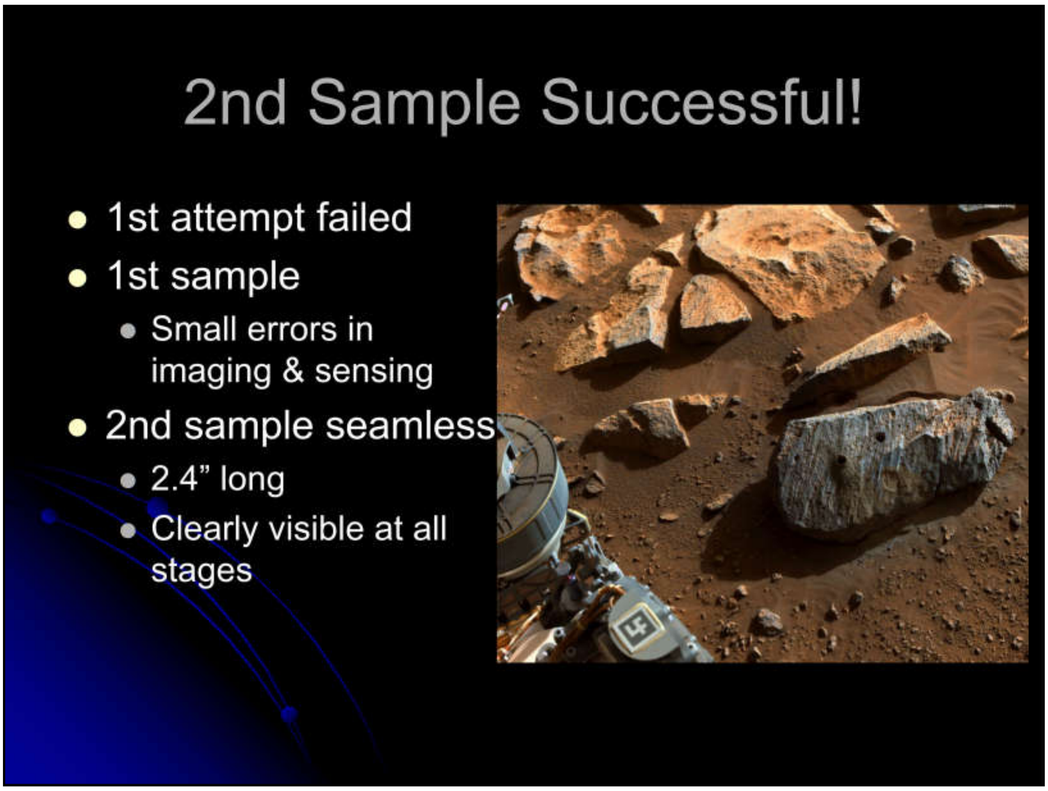
Fortunately, there are similar paver stones available in this area which we feel have a better chance of being compatible with of our sampling system. Since at present our plan is to drive back the way we came, there is a high probability we will revisit sampling of these rocks at a later date.



https://mars.nasa.gov/news/9027/nasas-perseverance-rover-successfully-cores-its-first-rock/

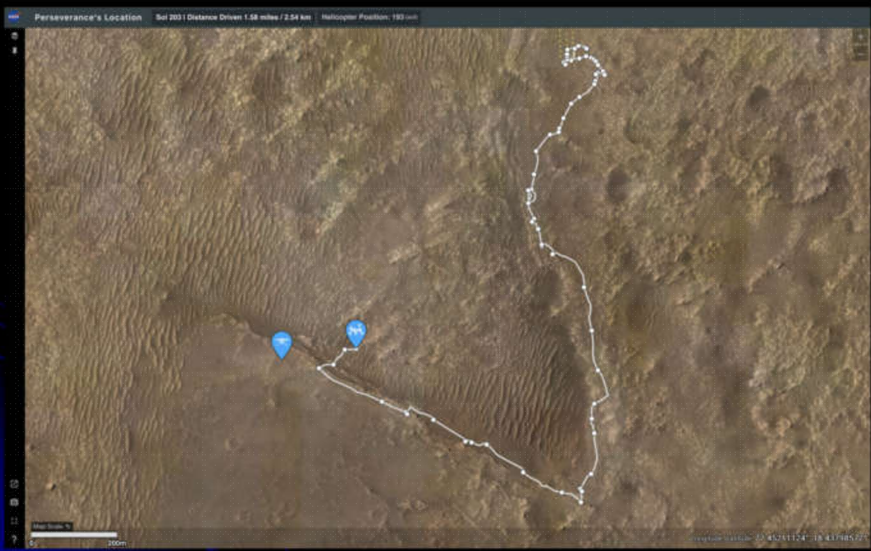
The initial set of images from Mastcam-Z showed the end of a cored rock within the sample tube. After taking these images, the rover began a procedure called “percuss to ingest,” which vibrates the drill bit and tube for one second, five separate times. The movement is designed to clear the lip of the sample tube of any residual material. The action can also cause a sample to slide down farther into the tube. After the rover finished the percuss-to-ingest procedure, it took a second set of Mastcam-Z images. In these images, the lighting is poor, and internal portions of the sample tube are not visible.

“The project got its first cored rock under its belt, and that’s a phenomenal accomplishment,” said Jennifer Trosper, project manager at NASA’s Jet Propulsion Laboratory in Southern California. “The team determined a location, and selected and cored a viable and scientifically valuable rock. We did what we came to do. We will work through this small hiccup with the lighting conditions in the images and remain encouraged that there is sample in this tube.”



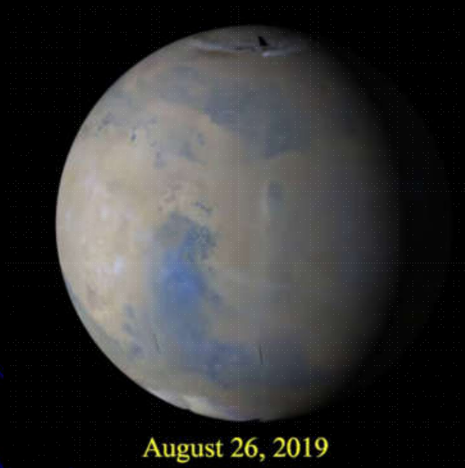
second attempt at a core sample was a success as well! The first one was a success, but there were some minor glitches with the sensors. The second one went perfectly.

Current Locations (Sept. 16)



https://mars.nasa.gov/resources/26247/where-is-perseverance-location-map/

Other Mars News



https://mars.nasa.gov/news/9039/nasa-confirms-thousands-of-massive-ancient-volcanic-eruptions-on-mars/

The team's analysis followed up on the work of other scientists who earlier suggested that the minerals on the surface of Arabia Terra were volcanic in origin. Another research group, upon learning that the Arabia Terra basins could be calderas, had calculated where ash from possible super eruptions in that region would have settled: traveling downwind, to the East, it would thin out away from the center of the volcanoes, or in this case, what's left of them: the calderas.

"So we picked it up at that point and said, 'OK, well these are minerals that are associated with altered volcanic ash, which has already been documented, so now we're going to look at how the minerals are distributed to see if they follow the pattern we would expect to see from super eruptions," Matiella Novak said.

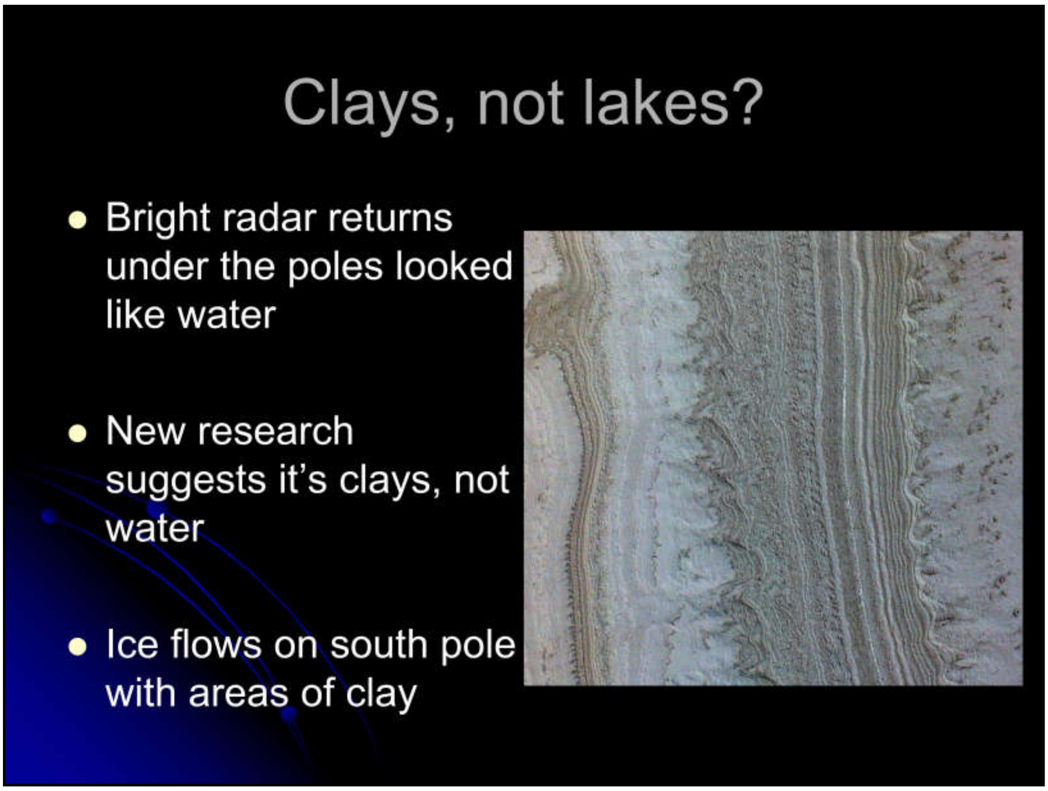
The team used images from MRO's Compact Reconnaissance Imaging Spectrometer for Mars to identify the minerals in the surface. Looking in the walls of canyons and craters from hundreds to thousands of miles from the calderas, where the ash would have been carried by wind, they identified volcanic minerals turned to clay by water, including montmorillonite, imogolite, and allophane. Then, using images from MRO cameras, the team made three-dimensional topographic maps of Arabia Terra. By laying the mineral data over the topographic maps of the canyons and craters analyzed, the researchers could see in the mineral-rich deposits that the layers of ash were very well preserved — instead of getting jumbled by winds and water, the ash was layered in the same way it would have been when it was fresh.

https://mars.nasa.gov/resources/25947/curiosity-spots-clouds-over-mont-mercou/?site=msl

May 28, 2021

NASA’s Curiosity Mars rover captured these clouds just after sunset on March 19, 2021, the 3,063rd Martian day, or sol, of the rover’s mission. The image is made up of 21 individual images stitched together and color corrected so that the scene appears as it would to the human eye. The clouds are drifting over “Mont Mercou,” a cliff face that Curiosity has been studying.

The rover captured the image using its Mast Camera, or Mastcam. Malin Space Science Systems in San Diego built and operates Mastcam. A division of Caltech, NASA’s Jet Propulsion Laboratory in Southern California built the Curiosity rover and manages the Curiosity rover for the agency’s Science Mission Directorate in Washington.

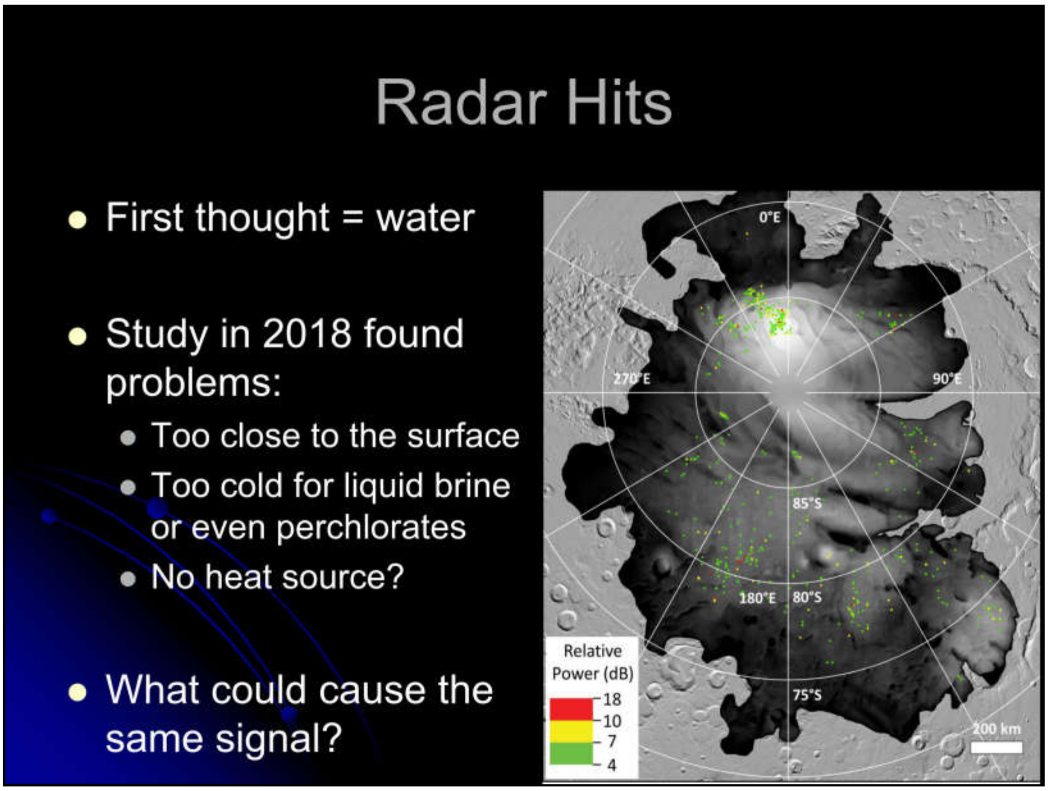


https://mars.nasa.gov/news/9000/clays-not-water-are-likely-source-of-mars-lakes/

Hence the interest generated in 2018, when a team led by Roberto Orosei of Italy's Istituto Nazionale di Astrofisica announced they had found evidence of subsurface lakes deep below the ice cap at Mars' south pole. The evidence they cited came from a radar instrument aboard the ESA (European Space Agency) Mars Express orbiter.

Radar signals, which can penetrate rock and ice, change as they're reflected off different materials. In this case, they produced especially bright signals beneath the polar cap that could be interpreted as liquid water. The possibility of a potentially habitable environment for microbes was exciting.

But after taking a closer look at the data, along with experiments in a cold laboratory here on Earth, some scientists now think clays, not water, might be creating the signals. In the past month, a trio of new papers have unraveled the mystery – and may have dried up the lakes hypothesis.



https://mars.nasa.gov/resources/25997/subsurface-lakes-or-something-else/

June 24, 2021

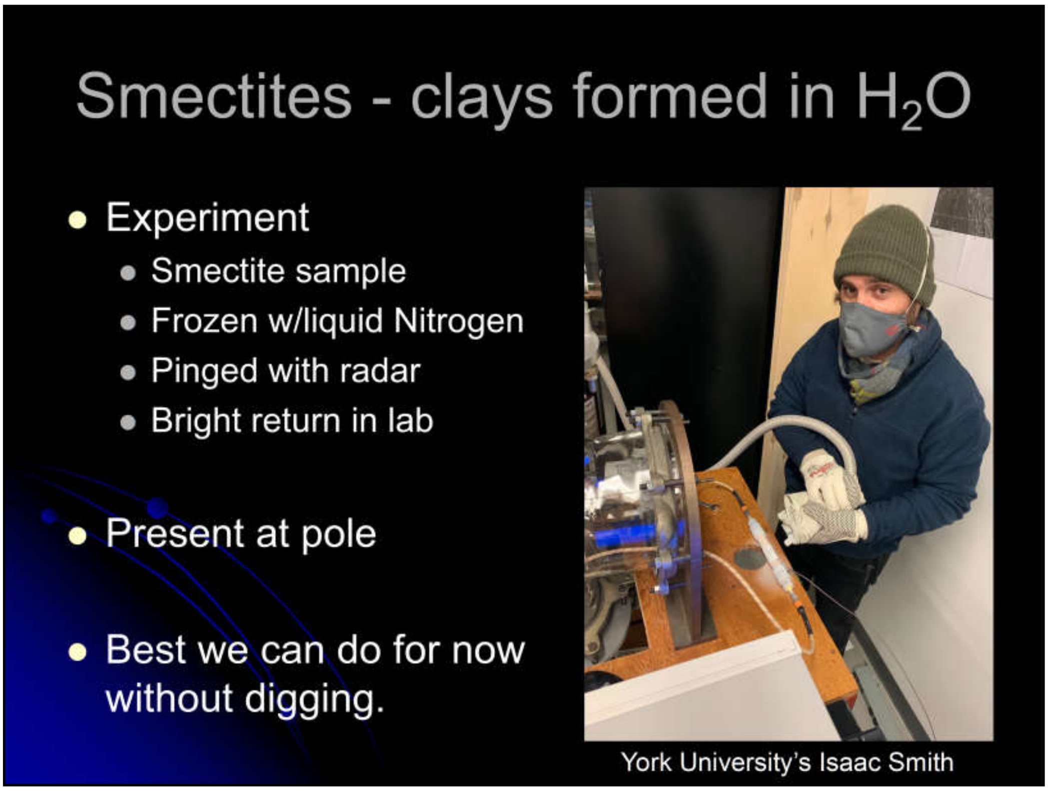
The colored dots represent sites where bright radar reflections have been spotted by ESA's Mars Express orbiter at Mars' south polar cap. Such reflections were previously interpreted as subsurface liquid water. Their prevalence and proximity to the frigid surface suggests they may be something else.

https://mars.nasa.gov/news/9000/clays-not-water-are-likely-source-of-mars-lakes/

Too Cold for Lakes

The colored dots represent sites where bright radar reflections have been spotted by ESA's Mars Express orbiter at Mars' south polar cap. Such reflections were previously interpreted as subsurface liquid water, but their prevalence and proximity to the frigid surface suggest they may be something else.

Two separate teams of scientists then analyzed the radar signals to determine whether anything else could be producing those signals.



https://mars.nasa.gov/news/9000/clays-not-water-are-likely-source-of-mars-lakes/

But York University's Isaac Smith, knowing that a group of clays called smectites were present all over Mars, went further in a separate, third paper: He measured smectite properties in a lab.

Smectites look like ordinary rock but were formed by liquid water long ago. Smith put several smectite samples into a cylinder designed to measure how radar signals would interact with them. He also doused them with liquid nitrogen, freezing them to minus 58 degrees Fahrenheit (minus 50 degrees Celsius) – close to what they would be at the Martian south pole.

After freezing the clay samples, Smith found their response nearly perfectly matched the MARSIS radar observations. Then, he and his team checked for clays present on Mars near those radar observations. They relied on data from MRO, which carries a mineral mapper called the Compact Reconnaissance Imaging Spectrometer, or CRISM.

Bingo. While CRISM can't peer through ice, Smith found smectites scattered in the vicinity of the south pole's ice cap. Smith's team demonstrated that frozen smectite can make the reflections – no unusual amounts of salt or heat are required – and that they're present at the south pole. There's no way to confirm what the bright radar signals are without landing at Mars' south pole and digging through miles of ice. But the recent papers have offered plausible explanations that are more logical than liquid water.

Links

- https://mars.nasa.gov/
- https://www.nasa.gov/perseverance
- https://www.jpl.nasa.gov/missions/mars-2020-perseverance-rover
- https://mars.nasa.gov/technology/helicopter/