




Pacific International Space Center for Exploration Systems



NEWSLETTER

 **Happy Holidays!**

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Chang'e-5 Mission to Retrieve Lunar Samples



China is on track to return to Earth the first lunar surface samples in more than four decades. On Nov. 23, the China National Space Administration (CNSA) launched its largest probe yet, Chang'e-5, with the objective of retrieving two kilograms of Moon rock and soil. Named after the Chinese moon goddess, the

probe includes a lander-ascender module and Earth re-entry capsule. The lander-ascender touched down on Dec. 1 at Mons Rümker, a mound located in Oceanus Procellarum (the Ocean of Storms)—a dark-grey region in the northwest corner of the Moon.

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Message from the Director

As we approach the end of what has been a highly unusual year, it is time to reflect on the many changes affecting our community, and the world at large. For me, the COVID-19 pandemic has been a valuable reminder of the delicate nature of life and appreciating the many things I often take for granted.

It has been touching to see our Big Island community rise to the challenges presented by coronavirus. In May, we joined forces with local STEM organizations, community members and students to address the outbreak by producing PPE for first responders, and health-care and community workers.

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Rodrigo Romo



First NASA-Certified Commercial Spaceflight Carries Astronauts to ISS

SpaceX broke new ground in space flight again last month after successfully launching a crew of four astronauts to the International Space Station aboard its Crew Dragon spacecraft. Launched by a Falcon 9 booster from NASA's Kennedy Space Center on Nov. 15, the mission marked the first operational flight for Crew Dragon after a successful test flight carried two astronauts to the ISS in May.

"NASA is delivering on its commitment to the American people and our international partners to provide safe, reliable and cost-effective missions to the International Space Station using American private industry," NASA Administrator Jim Bridenstine

said in a press release following the launch.

The crew, who named their spacecraft "Resilience", included NASA astronauts Michael Hopkins, Victor Glover and JAXA astronaut Soichi Noguchi. Twenty-seven hours after leaving Earth, the quartet arrived at their destination with 500 lbs. of scientific hardware and experiments to be conducted over the next six months. Instead of the usual maneuvers requiring a pilot at the helm, Dragon docked with the ISS autonomously—a feat reminiscent of a Tesla parking itself, only in a much trickier parking space.

Resilience crew members joined the current inhabitants of the ISS, Expedition 64, who include Roscosmos cosmo-

nauts Sergey Ryzhikov and Sergey Kud-Sverchkov, and NASA astronaut Kate Rubins. Together, the two crews make up the largest crew to live on the ISS at the same time. The three-seat capacity of Russia's Soyuz capsule previously limited crew sizes aboard the ISS to six. Dragon's four seats enable an extra hand on deck at the orbiting laboratory. Though quarters will be tight, a larger crew means more space research and experiments can be accomplished—and there are many on the mission agenda.

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Left: The crew of Resilience inside the Crew Dragon cockpit.

Below: Falcon 9 and Resilience on the launchpad ahead of launch. Credits: SpaceX



Using ISRU 3D Printing Systems for Sustainable Construction on Earth

By: Keegan Kirkpatrick - Founder & CEO, RedWorks

RedWorks Construction Technologies Inc. is proud to be partnered with PISCES and our continued collaboration in ISRU development has been a testament to how space-based research can benefit and disrupt industries on Earth. Over the last few years, RedWorks has been carrying out a battery of tests for regolith 3D printing systems we developed from technology that was originally intended to print the first habitats on the Moon and Mars. We've been testing literally anything we can get our hands on: pre-sifted, fine grain riverbed sand, simulated Martian regolith, even dirt pulled from our own backyards. Regardless of the origin, we're almost always able to turn dirt into rock that will one day help build homes on Earth and habitats in space. Thanks to

the research and advice from our friends at PISCES, we know this material can withstand the same rigors as traditional building materials.

Like PISCES, RedWorks' goal is to radically disrupt the construction industry's byzantine supply chain. Instead of shipping concrete or bricks to a site on diesel-burning ships, trains and trucks, or building an expensive concrete plant near-site, a builder can make all the masonry needed completely on-site. This means greener, cheaper building materials, with no delays due to shipping or waste.

We are working tirelessly to bring this technology to build-

ers as soon as possible to begin building homes where no one thought possible—all while making it cheaper to source materials and gather them more locally. We want to make it possible for Hawaii's builders to never be dependent on mainland or foreign suppliers, but also for those in less-developed places to build regardless of the presence of infrastructure that many markets take for granted. Imagine seeing cities rise out of barren deserts, or ports emerge from the ocean floor itself—all from ordinary dirt and sand that would normally be thrown away. That is the power of this technology. It grants anyone the ability to build anywhere, limited only by their imagination.

Below: RedWorks is testing various types of dirt and sand to create feedstock for 3D printing systems that can build habitats on Earth and in space. Credit: RedWorks



Cont: Chang'e-5 Mission to Retrieve Lunar Samples ...

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Chang'e-5's landing site is expected to be composed of rock and soil that are some 1.2 billion years old—much younger than the 3 to 4 billion-year-old samples NASA's Apollo astronauts retrieved. The lander will drill two meters beneath the surface for rock, aided by a robotic arm to gather surface soil.

Once these samples are successfully returned to lunar orbit and transferred to the Earth re-entry vehicle, the lander will remain on the surface to capture data on the topography, geological composition and sub-surface structures present at the landing site.

China has stated that back on Earth, the lunar samples will be available for study by researchers around the world. Scientists are excited about



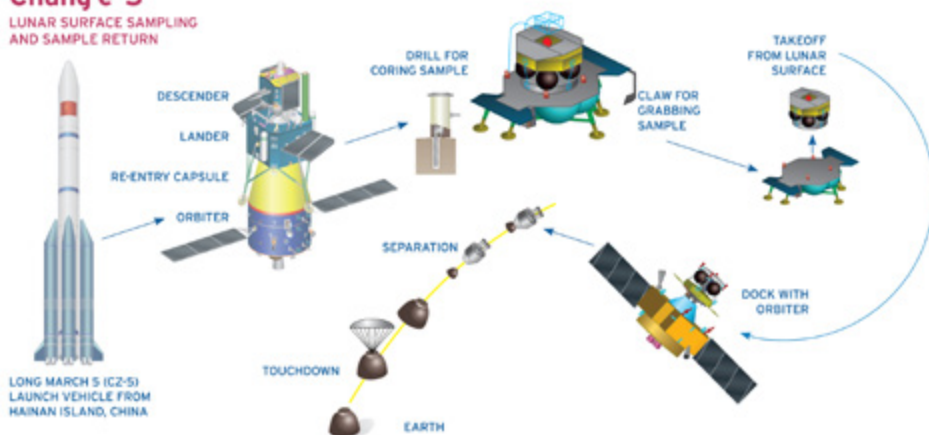
examining rock that formed relatively late in the Moon's geological timeline. Knowing the Moon's history will also broaden our understanding of Earth's formation and the other bodies in our solar system. Chang'e 5 is also a test for China's space engineering prowess, demonstrating autonomous lunar sampling, moon-based launching

and lunar orbital docking. The mission support's China's longer-term goals for future human missions to the Moon and beyond.

Chang'e-5's mission is scheduled to last about 23 days, returning to Earth on Dec. 16 or 17. It will be the first spacecraft to bring back lunar material since the former Soviet Union's Luna 24 mission in 1976. If successful, China will be the third nation to capture lunar rock, following the U.S. and the Soviet Union.

Above: Chang'e 5 blasts off on a Long March 5 heavy lift rocket from Wenchang Space Launch Center on Nov. 23. Credit: CNSA/CAS
Left: Chang'e 5's mission profile involves several steps to retrieve samples from the lunar surface. Credit: [The Planetary Society](#).

Chang'e-5 LUNAR SURFACE SAMPLING AND SAMPLE RETURN



Cont: Director's Letter...

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Seeing the community come together to support those most at risk of infection was truly a testament to the Aloha Spirit that lives in Hawaii.

In space exploration, we close the year with inspiration. SpaceX successfully completed its first operational Crew Dragon mission to the ISS, carrying four astronauts to space and returning human launches to American soil. And as I write these words, Mars 2020 is speeding to the Red Planet, bringing groundbreaking new discoveries into reach.

These missions are part of a larger series of amazing feats that happened in aerospace this year—the span of which are too many to name in this brief letter. But I anticipate 2021 will be another incredible year, with new science and technological advancements that will continue to push the boundaries of our exploration of space.

May you have happy and safe holidays,

Rodrigo Romo
PISCES Program Director

Right: Commander Mike Hopkins (left) and Pilot Victor Glover (right) watch their screens as the Crew Dragon Resilience approaches the ISS just before docking on Nov. 16, 2020. **Credit: NASA**

Cont: First NASA Commercial Spaceflight Carries Astronauts to ISS ...

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One study will examine how spaceflight affects the human brain; another the impacts of microgravity and optimized diets on crew health. In a continuing effort to grow food in space, crew members will also experiment with growing radishes in varying soil and light conditions. A cooling system for NASA's next generation spacesuits will also be tested. With these experiments and others, humans will be better equipped for long-duration space missions to destinations like Mars.

With NASA's official stamp of approval on Dragon for human spaceflights, SpaceX will

be ferrying crews of international astronauts to and from the ISS a few times a year—all while saving NASA tens of millions of dollars.

SpaceX's latest flight is the first of six planned flights in NASA's Commercial Crew Program.

In Spring 2021, the Resilience crew will reenter their spacecraft, undock and re-enter Earth's atmosphere, plummeting into the Atlantic Ocean off the Florida coast where a recovery ship will retrieve them. Their return will mark the longest human space mission launched from the US to date.

[View the launch >>](#)

