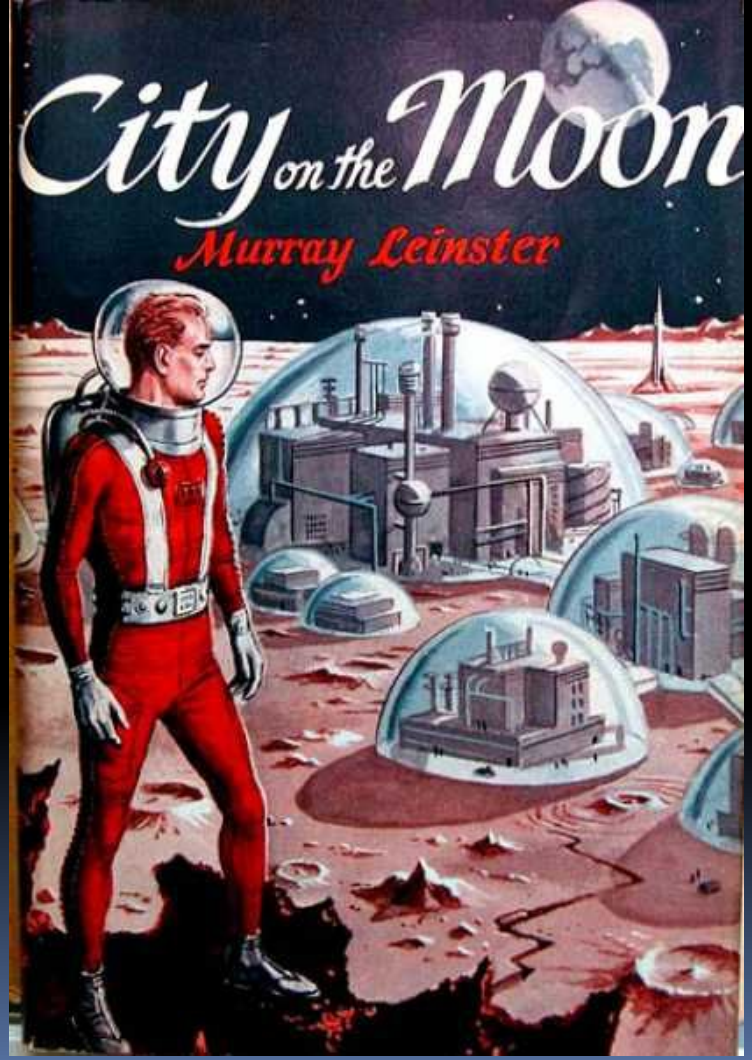
“BACK TO THE MOON... A Look at Global Indicators”

Rob Kelso, NSS Board of Director

Founder, Kelso Aerospace

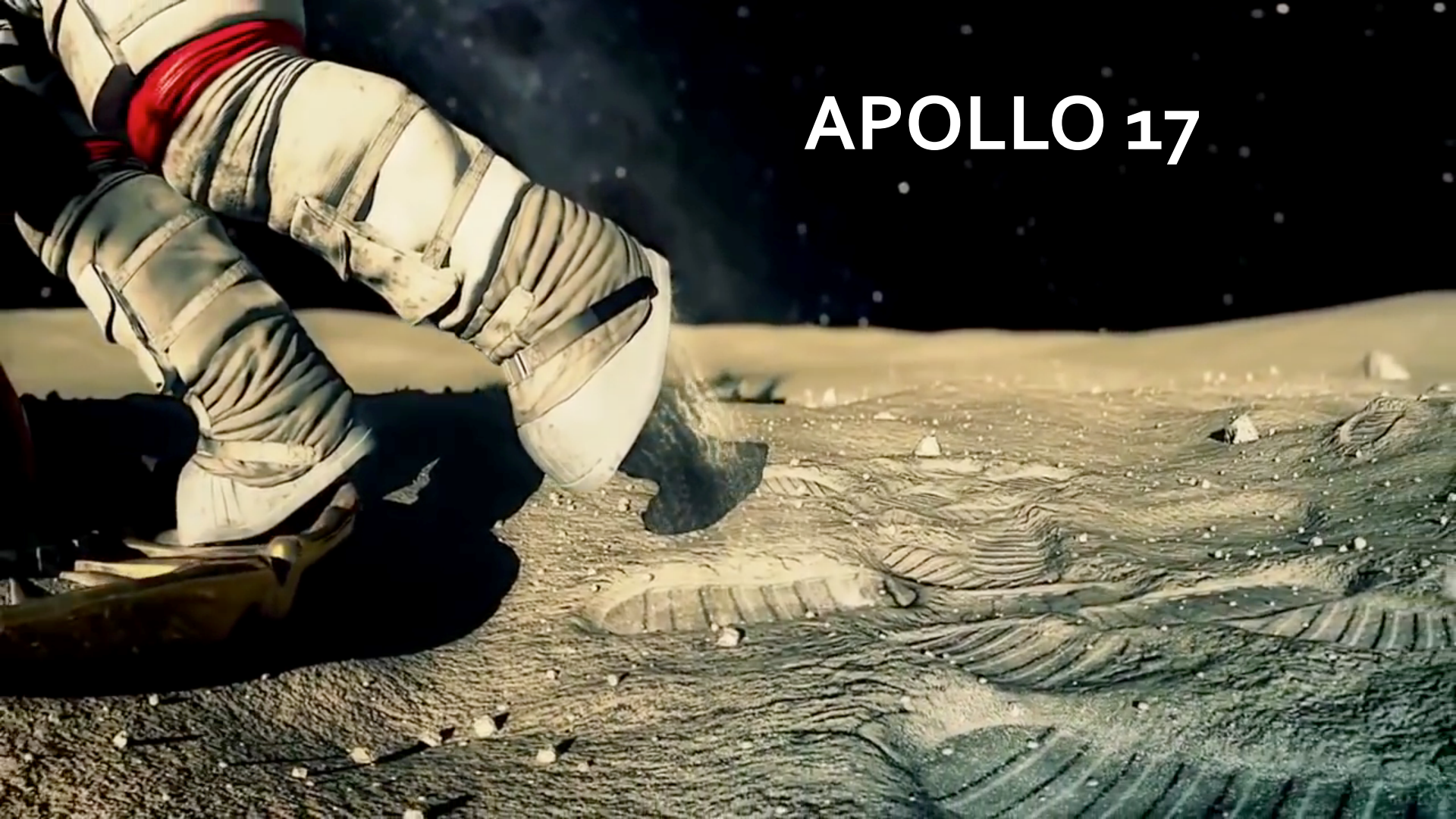

MOON BASE
BY WILLIAM NEPHEW AND MICHAEL CHESTER
ILLUSTRATED BY WALTER BUEHR


City on the Moon
Murray Leinster


A RIDLEY SCOTT FILM
BRING
HIM
HOME
MATT DAMON
THE MARTIAN
IN CINEMAS SEPTEMBER 30 IN 3D


Planetary Settlement is not a question of “IF” …rather a question of “WHEN”.


Bummer.
United States
Gulf of Mexico
Chicxulub
Crater
Mexico
Yucatan


APOLLO 17

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White House nominates Bridenstine as NASA administrator

- **The White House announced Sept. 1 that President Trump planned to nominate Rep. Jim Bridenstine (R-Okla.) as NASA administrator.**

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What might be a new direction for NASA under the new Administrator?

- ***"To be among those who first arrive at a destination in space and to open it for subsequent use and development by others."***
  - **keeping NASA a "cutting edge" entity that pushes the envelope of spaceflight.**
  - **…charging the agency with enabling the subsequent exploration and use of new destinations by a variety of users, both public and private.**
  - **Example: NASA's goal is NOT to "mine the Moon," but to establish that the Moon *CAN* be mined, and to open the window on what new technology development is needed for such a task.**

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Recent changes in the Landscape

- Rumors of considering a “Return to the Moon” by the Trump administration
- Bezos: “Blue Moon” cargo-delivery service to the surface of the Moon
- SpaceX plans to send two people around the Moon in late 2018
- NASA Announces Plans To Test Deep Space Exploration With New Moon-Orbiting Spaceport
- International Space Agency Heads See the Moon on the Path to Mars (April 2017)

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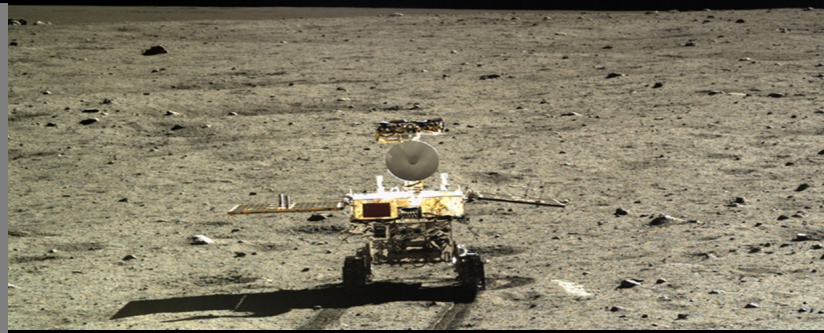
Recent changes in the Landscape

- NASA RFI Seeks Additional Information on **Small Lunar Surface Payloads** (Nov 1, 2016)
- NASA - Lunar Surface Cargo Transportation Services Request for Information (RFI) (May 1, 2017)
  - seeks details from U.S. companies about **commercial lander systems** to deliver "instruments, experiments, or other payloads" to the surface of the moon
- NASA AES has two forthcoming BAAs: (1) funding of landed lunar instruments and (2) landed services for provider companies. (briefed at LPSC in March 2017)

Recent changes in the Landscape

- **China eyes manned lunar landing by 2036**
  - On Dec 2013, the country's Chang'e 3 successfully reached the Moon
  - The next unmanned lunar mission, Chang'e 4, was planned for December 2018 *(different booster than Long March 5?)*
  - China's first sample return mission, designated Chang'e 5, was postponed to 2020 due to the recent failure of a Long March 5 launcher.

"The Chinese clearly have a very ambitious program of lunar exploration operating on what can only be described as an 'aggressive' timescale."



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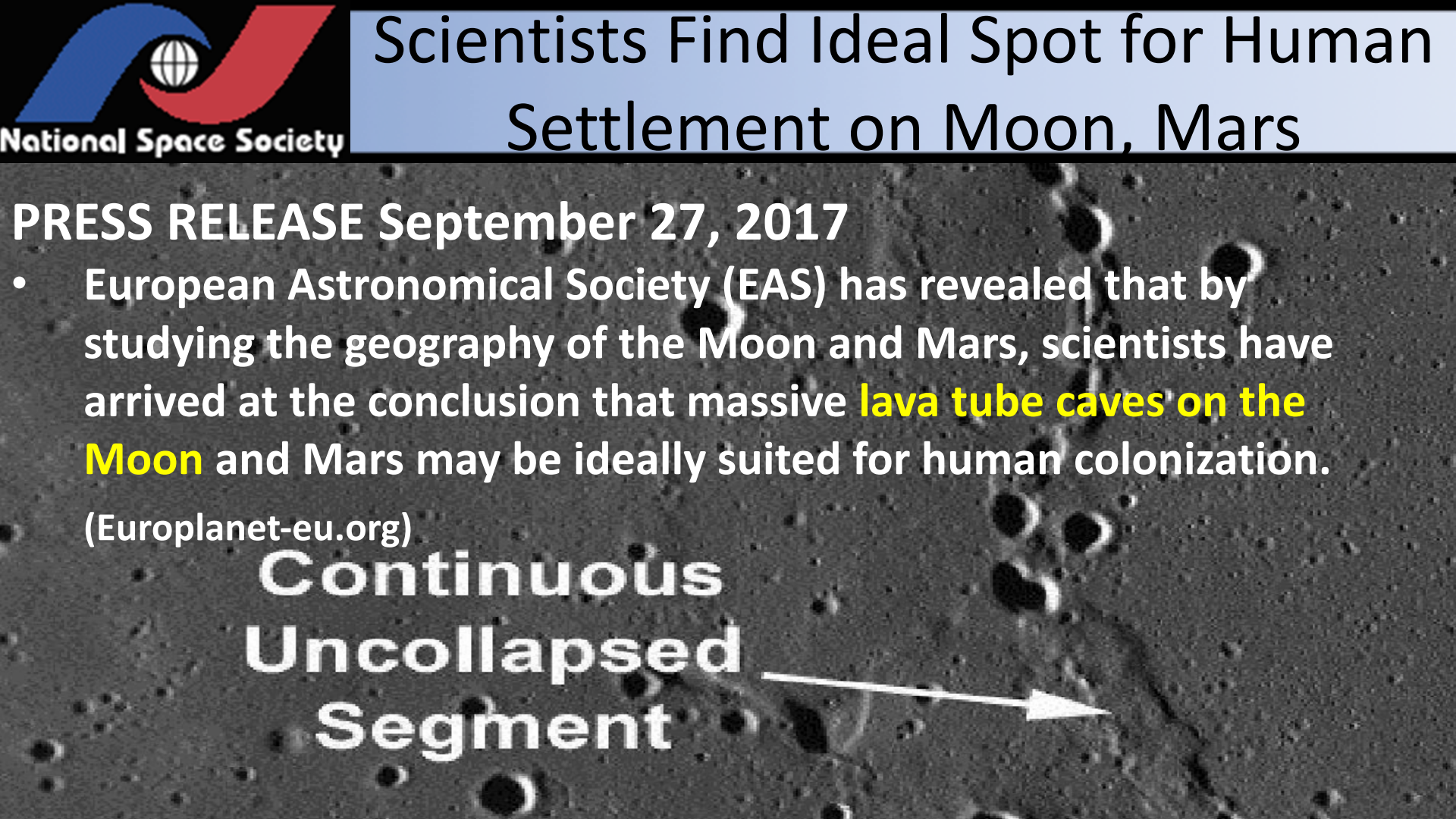
Scientists Find Ideal Spot for Human Settlement on Moon, Mars

PRESS RELEASE September 27, 2017

- **European Astronomical Society (EAS) has revealed that by studying the geography of the Moon and Mars, scientists have arrived at the conclusion that massive lava tube caves on the Moon and Mars may be ideally suited for human colonization.**

(Europlanet-eu.org)



Future Lunar Exploration Timeline

- **2017**
  - Originally planned for November: Chang-E-5, near side sample return *
- **2018**
  - Change'E-4, far side lander and rover *
  - SpaceX human lunar orbiter

* Long March 5 failure to postpone mission

Future Lunar Exploration Timeline

- **2019**
  - Luna-Glob, Luna 25, will be the next Russian lunar mission, landing near the lunar south pole
  - Possible selection of NASA Moonrise
  - NASA Exploration Mission (EM) 1: NET December 2019
- **2020**
  - Luna-26, lander
  - Chang'E-5, lander and far side sample return

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Future Lunar Exploration Timeline

- **2021-22**
  - Luna-27, lander
  - NASA EM-2 human mission, Orion/SLS 1B lunar orbit
- **2022-30**
  - Luna-28, lander, sample return
  - Luna-29, lander and rover
  - First human launch Federaysiya late 2023
  - NASA Moonrise far side sample return, launch 2024

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Recent changes in the Landscape

- **Commercial Lunar Lander activity - Astrobotic**
  - **Astrobotic's Private Moon Lander Will Launch in late 2019 atop a United Launch Alliance (ULA) Atlas V rocket**
  - **During the 2019 mission, Peregrine will carry 77 lbs. (35 kilograms) of payload to the lunar surface.**

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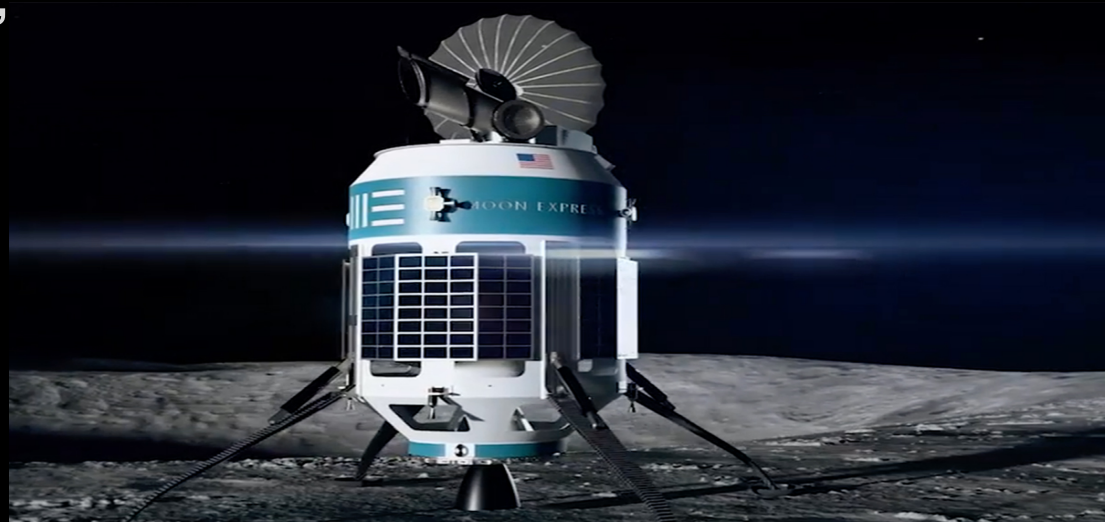
Recent changes in the Landscape

- **Commercial Lunar Lander activity – Moon Express**
  - **Launch planned for early 2018 on Rocket Lab's Electron**
  - **MX-1E can land up to 66 pounds on the lunar surface and is also designed to "hop"**

MX-1E



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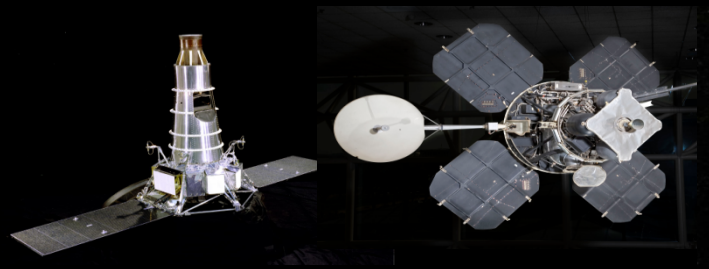
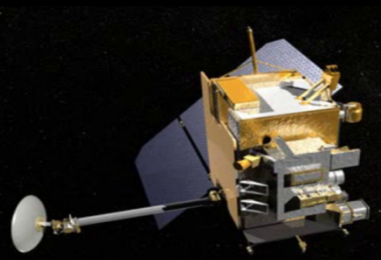
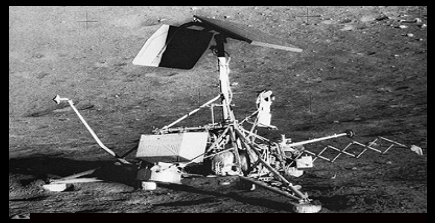
Comparing to Preparation for Apollo Landings

	APOLLO	TODAY
Lunar Orbit Data		
Lunar Surface		?
Technology Testing		?

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The critical role of ISRU

- Volatiles / Propellant
- Lunar Construction

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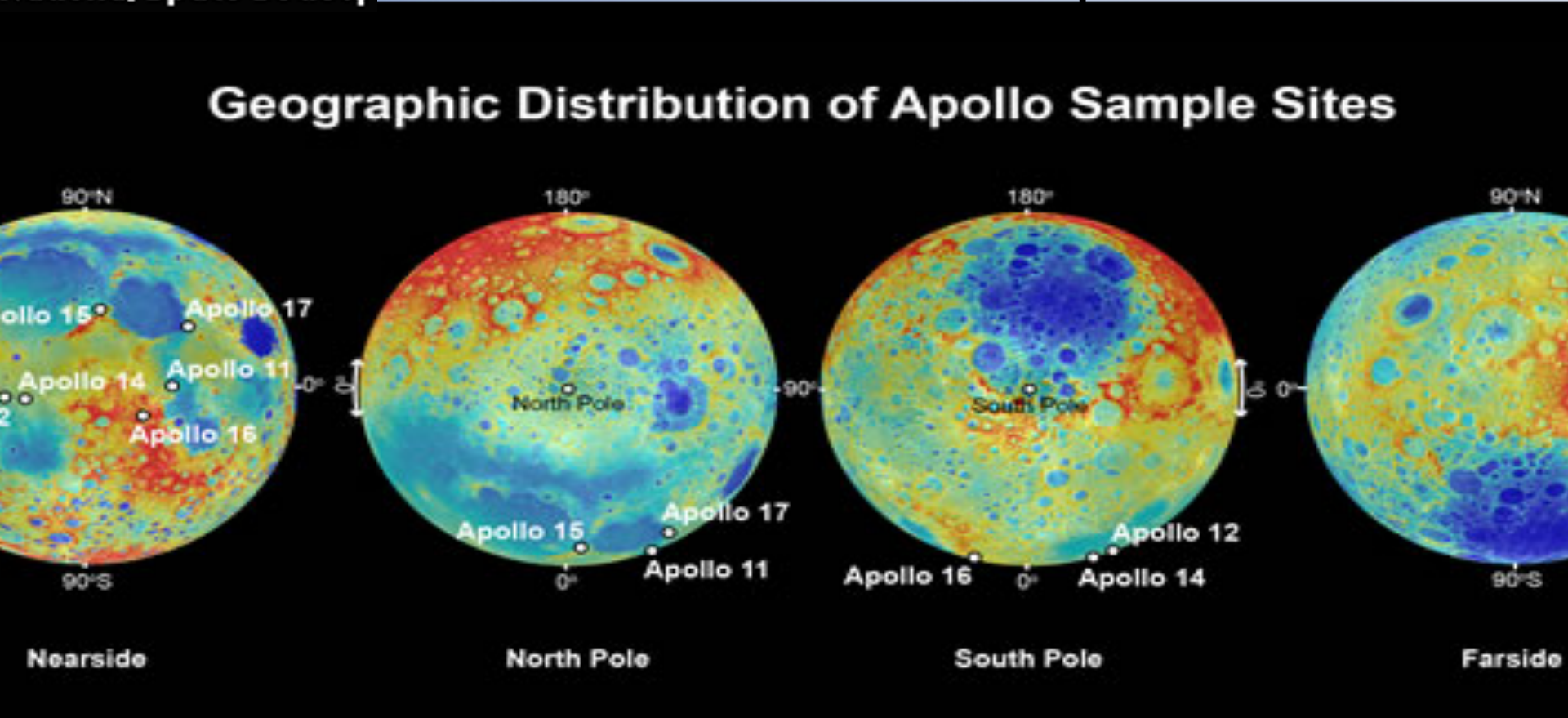
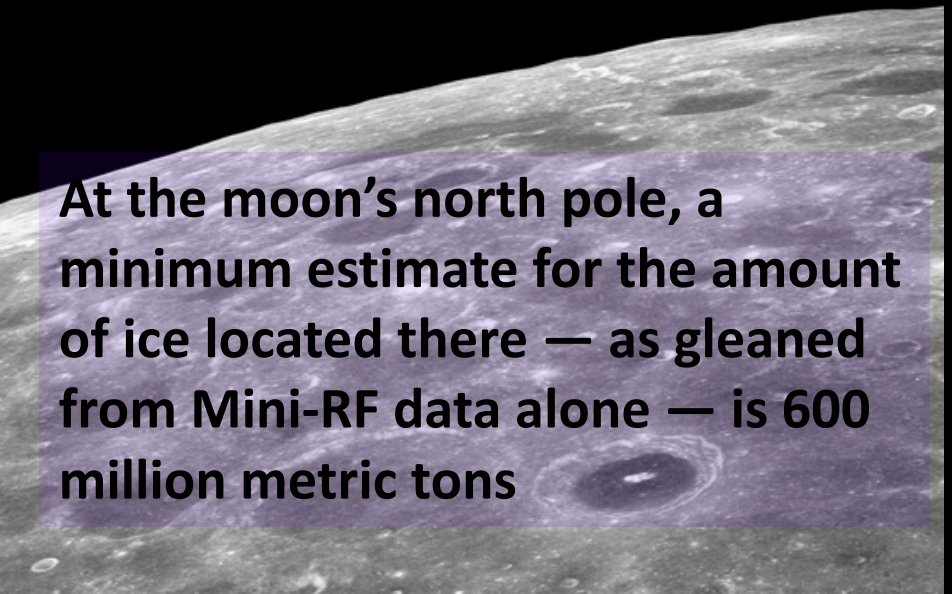
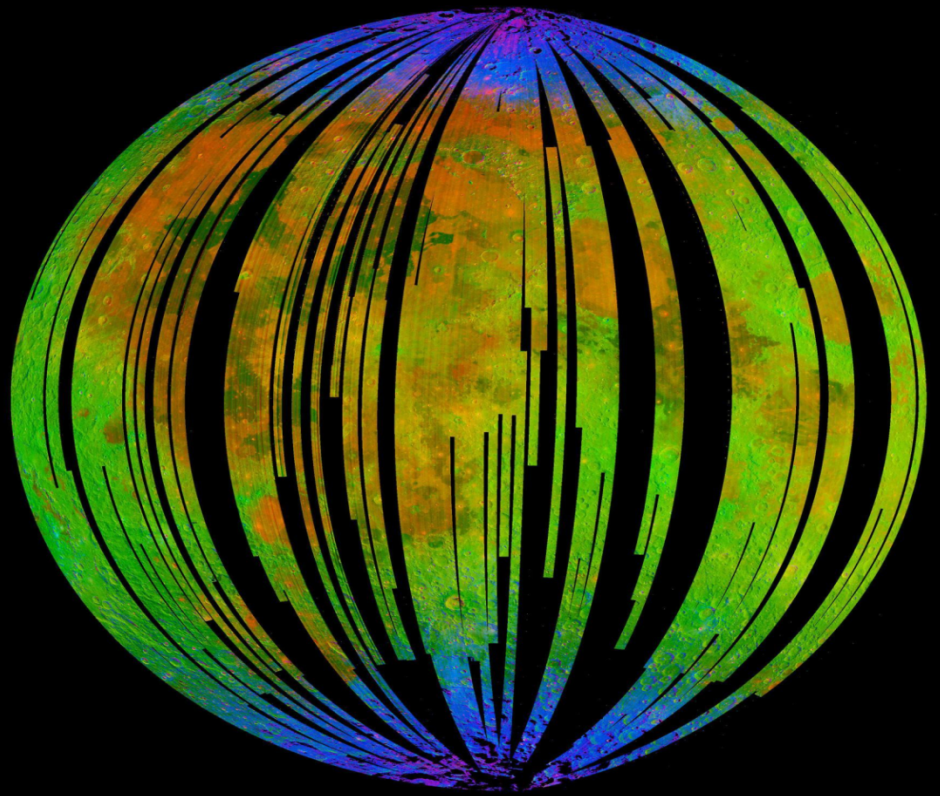
Less than 5% of the moon's surface has been explored



Lunar Water Creates New Capabilities in Space

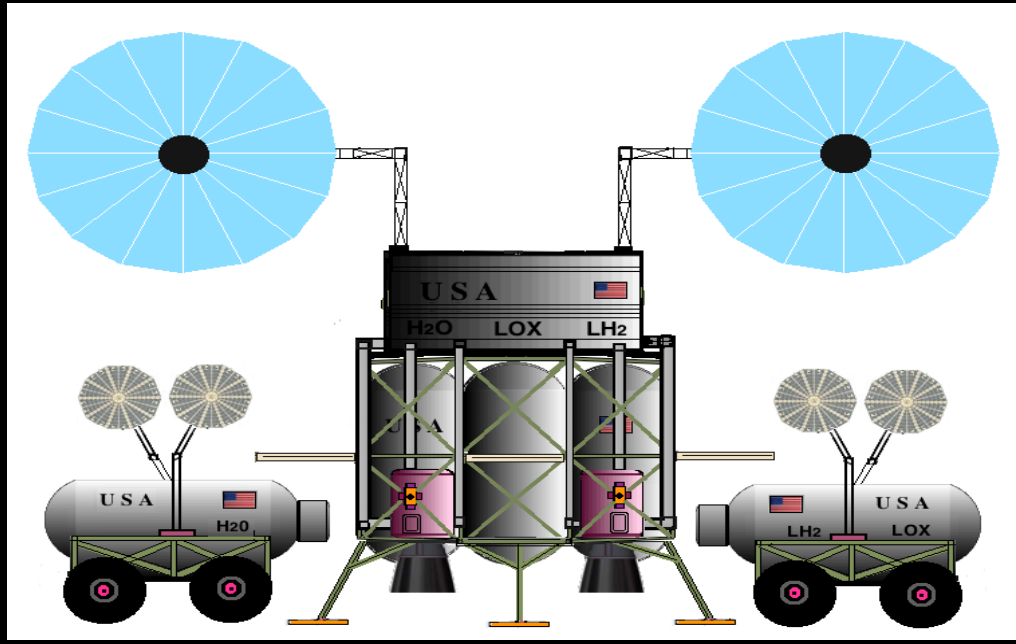




At the moon's north pole, a minimum estimate for the amount of ice located there — as gleaned from Mini-RF data alone — is 600 million metric tons

ISRU #1: Lunar Consumables

- HYDROGEN / OXYGEN
  - propellant,
  - fuel cell reactants,
  - life support



ISRU #2: Lunar Construction

- LUNAR CONSTRUCTION / CIVIL ENGINEERING
  - Roads,
  - Landing pads,
  - Infrastructure
  - Building Codes
  - Site survey
  - Drilling

ISRU #3: Resource Prospecting

- RESOURCE PROSPECTING
  - lunar ice/volatiles
  - some metallics

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ISRU #4: Energy

- ENERGY
  - Solar Array Production
  - Thermal Storage

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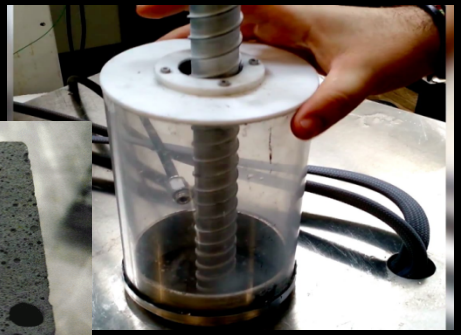
What have we yet to learn in operating on the surface of the Moon?

- Drilling and anchoring
- How to make a brick
- How to build a landing pad
- Nature of the ice/water



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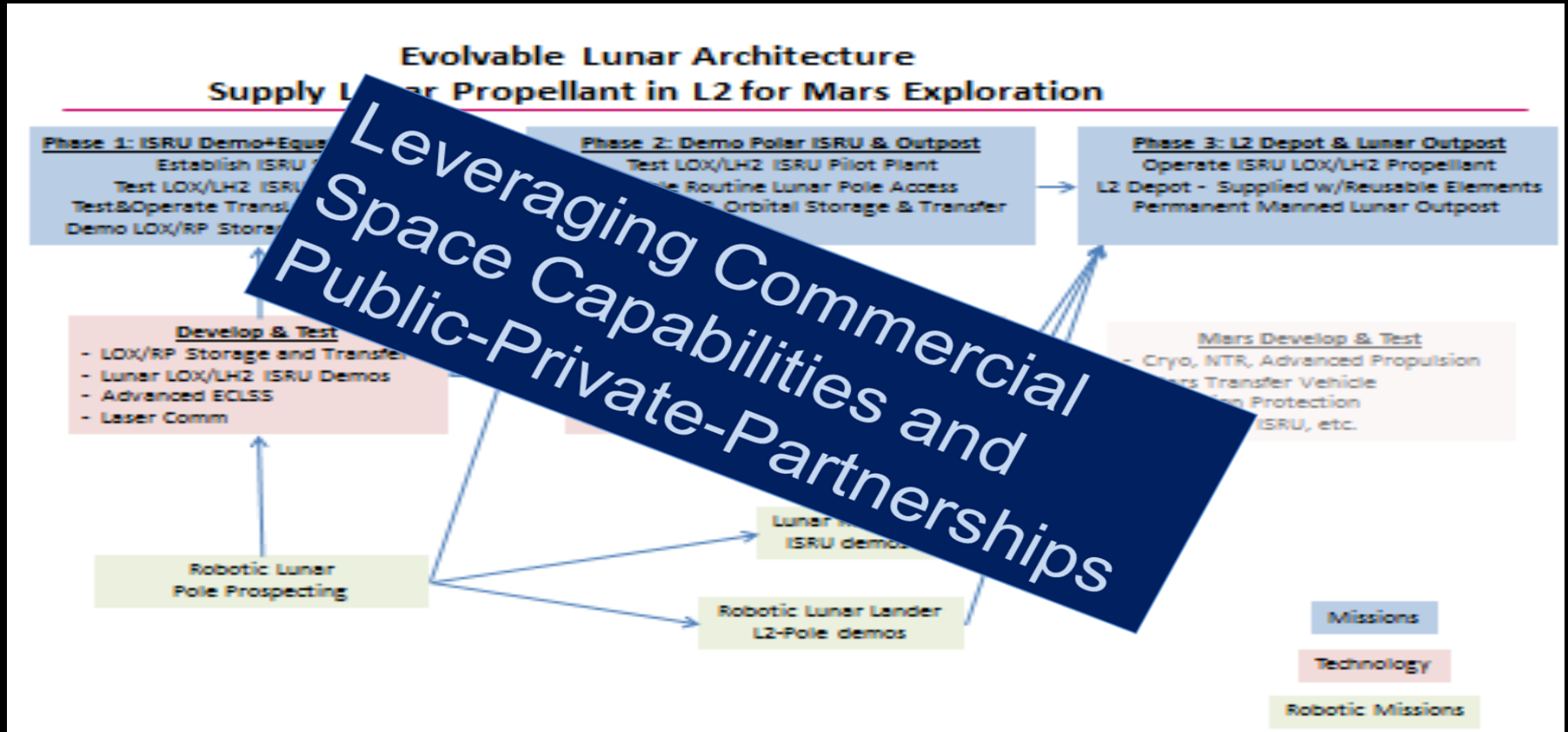
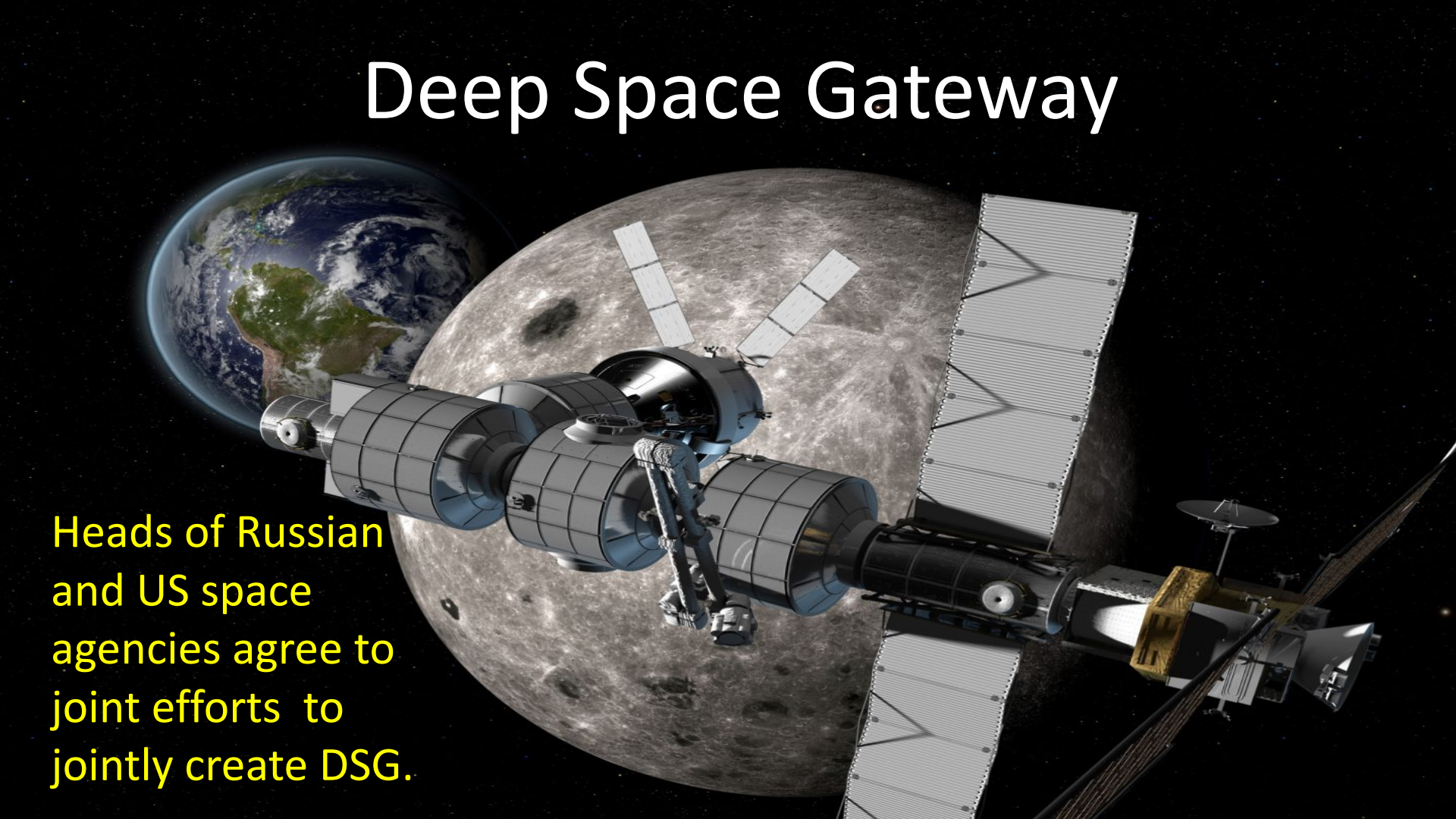
Evolvable Lunar Architecture



Deep Space Gateway



Heads of Russian and US space agencies agree to joint efforts to jointly create DSG.

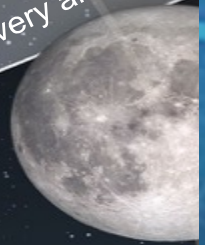
Exploring Space In Partnership

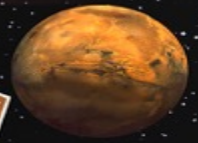
Now
Using the International Space Station

2020s
Operating in the Lunar Vicinity

2030s
Leaving the Earth-Moon System and Reaching Mars Orbit

Advancing technologies, discovery and creating economic opportunities





Phase 0

Solve exploration mission challenges through research and systems testing on the ISS. Understand if and when lunar

Phase 1

Conduct missions in cislunar space; assemble Deep Space Gateway and Deep Space Transport

Complete Deep Space Transport and conduct Mars verification mission

Missions to the Mars system, the surface of Mars

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International Collaboration
ESA Moon Village

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Global Partnership Strategy

Given their broad-based value, PARTNERSHIIPS are essential.

NSS: “Return to the Moon”

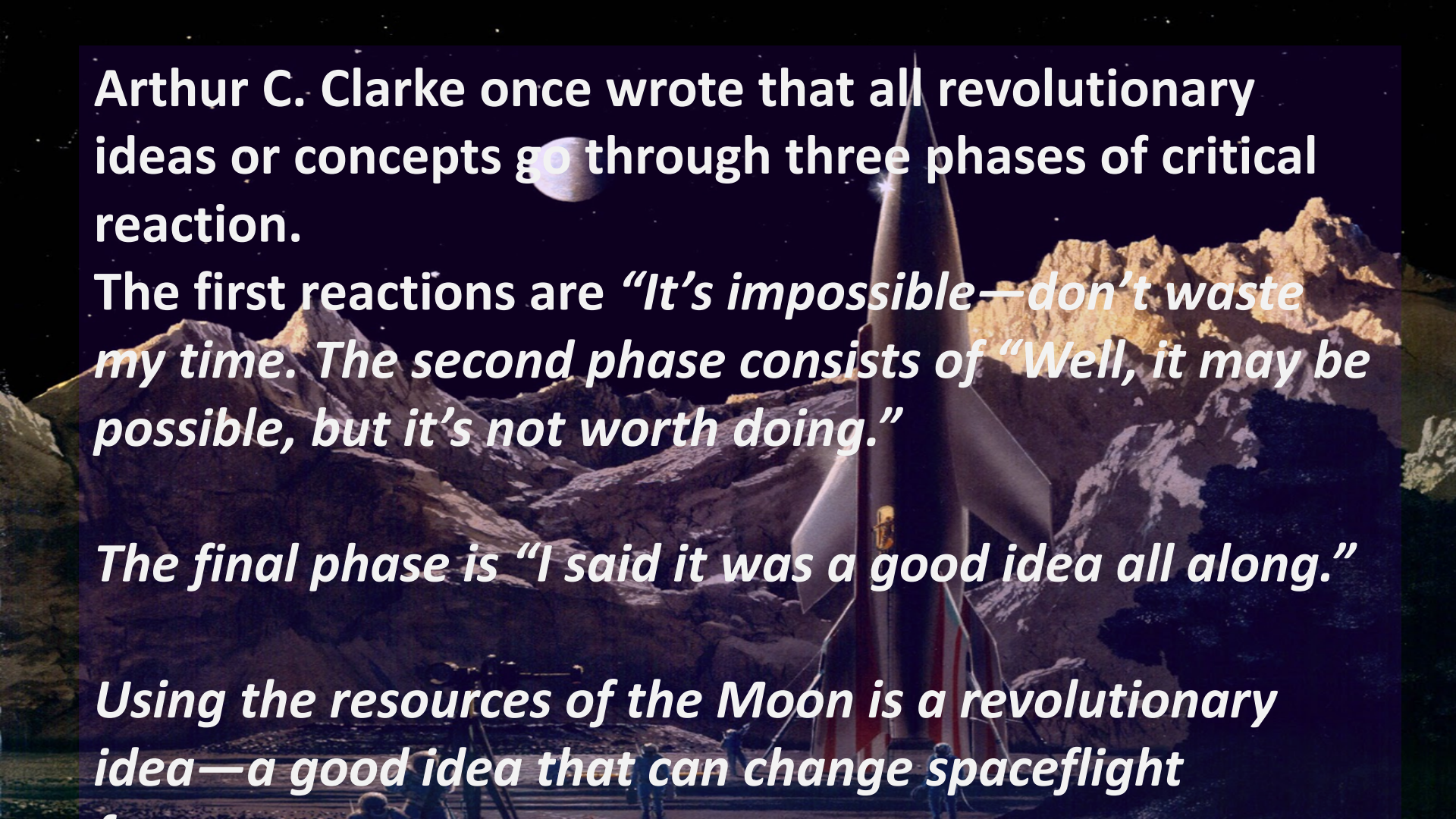
The Moon serves two primary purposes:

1. **a return to the Moon allowed us to develop and test the technologies, hardware and procedures needed for future human exploration beyond LEO; and**

2. the use of the material and energy resources of the Moon would enable the creation of new spaceflight capabilities.

NSS Strategic Goal

1. Promote the economic development of cis-lunar space and a thriving space economy
2. Promote the utilization of space resources including lunar, asteroidal and solar energy
3. Promote a "*return to the Moon*" this time to stay in a fashion that stresses sustainability, public-private partnerships, commercial approaches and the enablement of Space Settlement [equating commercial space and space settlement]
4. Promote the development of self-sustaining habitats



Arthur C. Clarke once wrote that all revolutionary ideas or concepts go through three phases of critical reaction.

The first reactions are *“It’s impossible—don’t waste my time. The second phase consists of “Well, it may be possible, but it’s not worth doing.”*

The final phase is “I said it was a good idea all along.”

Using the resources of the Moon is a revolutionary idea—a good idea that can change spaceflight

Mahalo Nui Loa