NASA's Lunar Exploration Program

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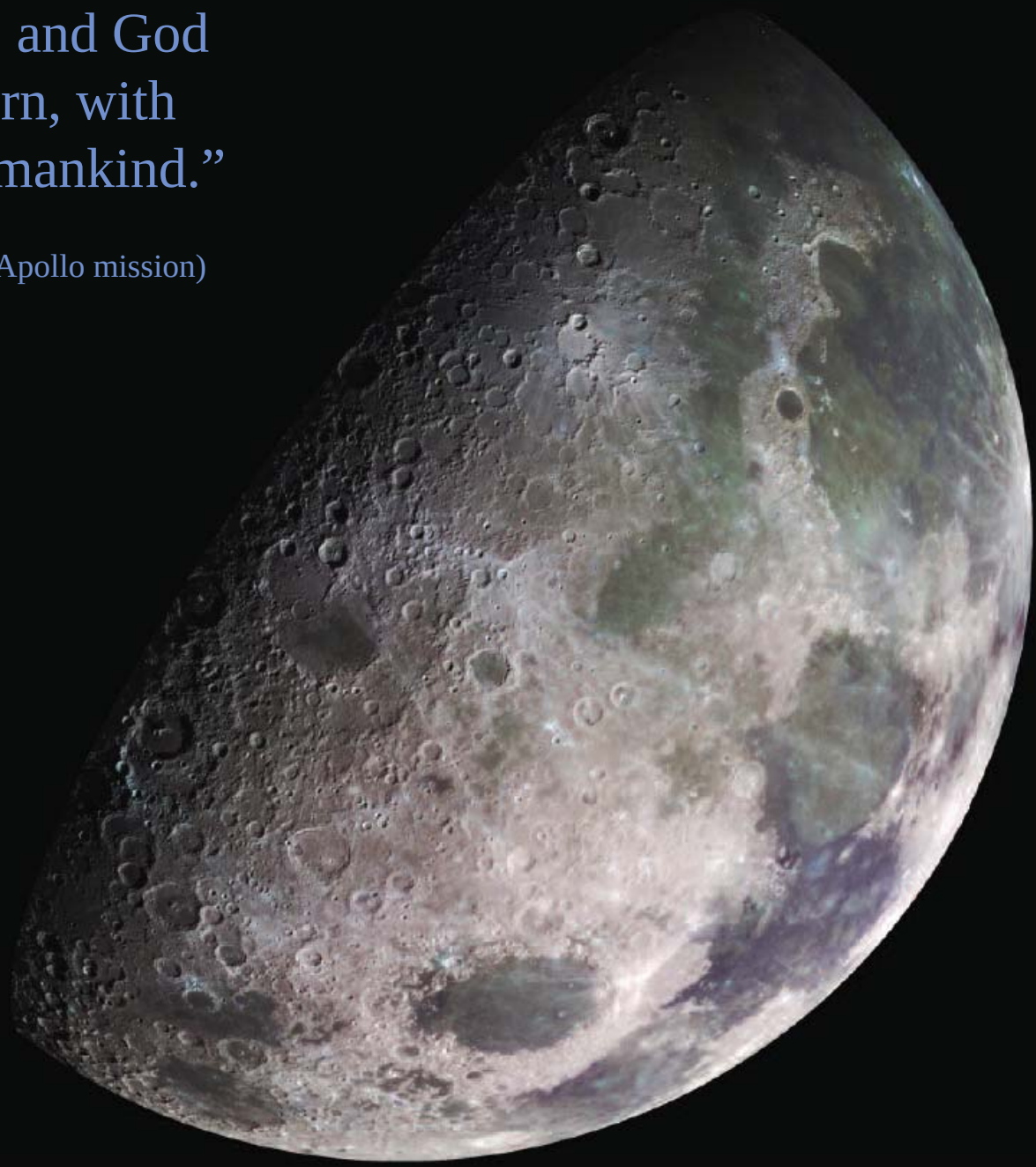
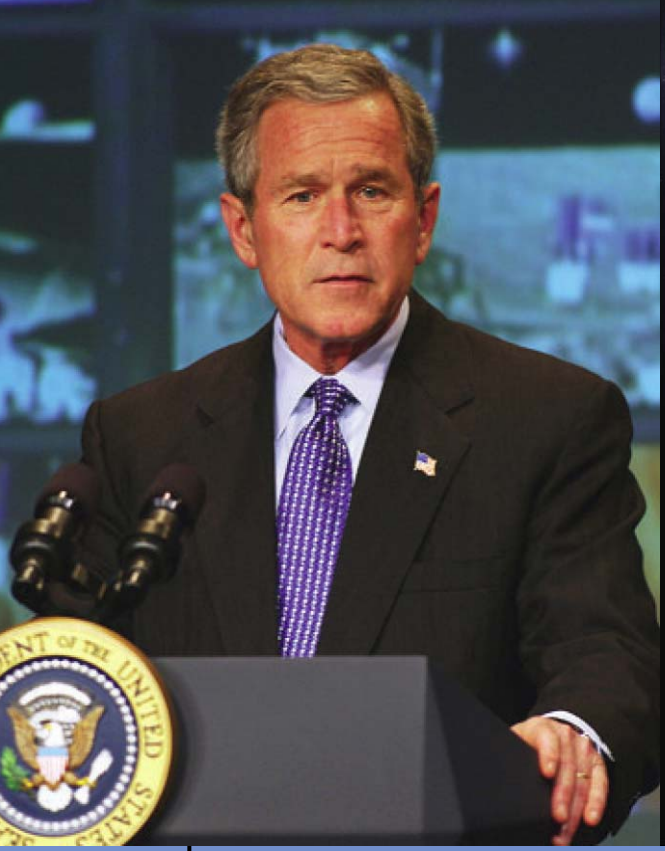
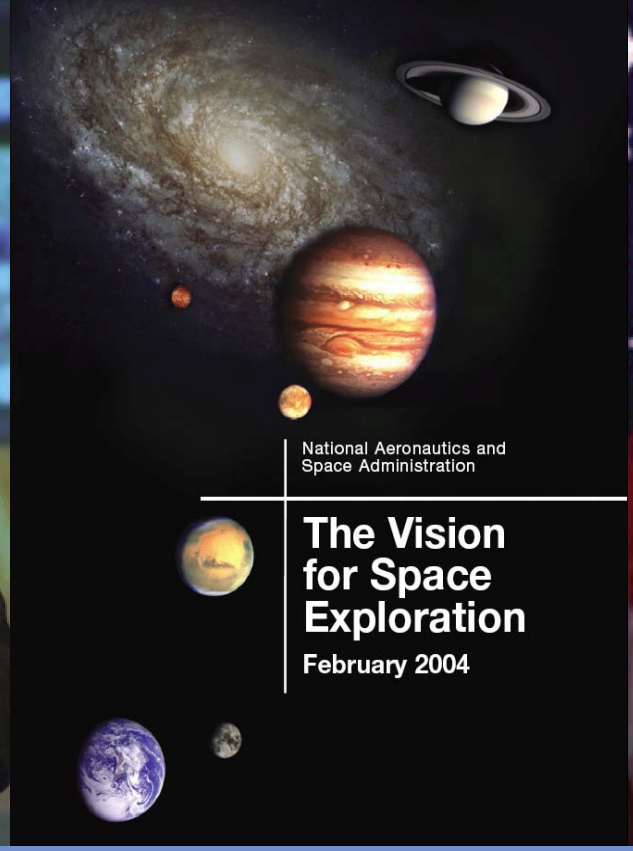
“We leave as we came, and God willing as we shall return, with peace and hope for all mankind.”

- Eugene Cernan (Commander of final Apollo mission)



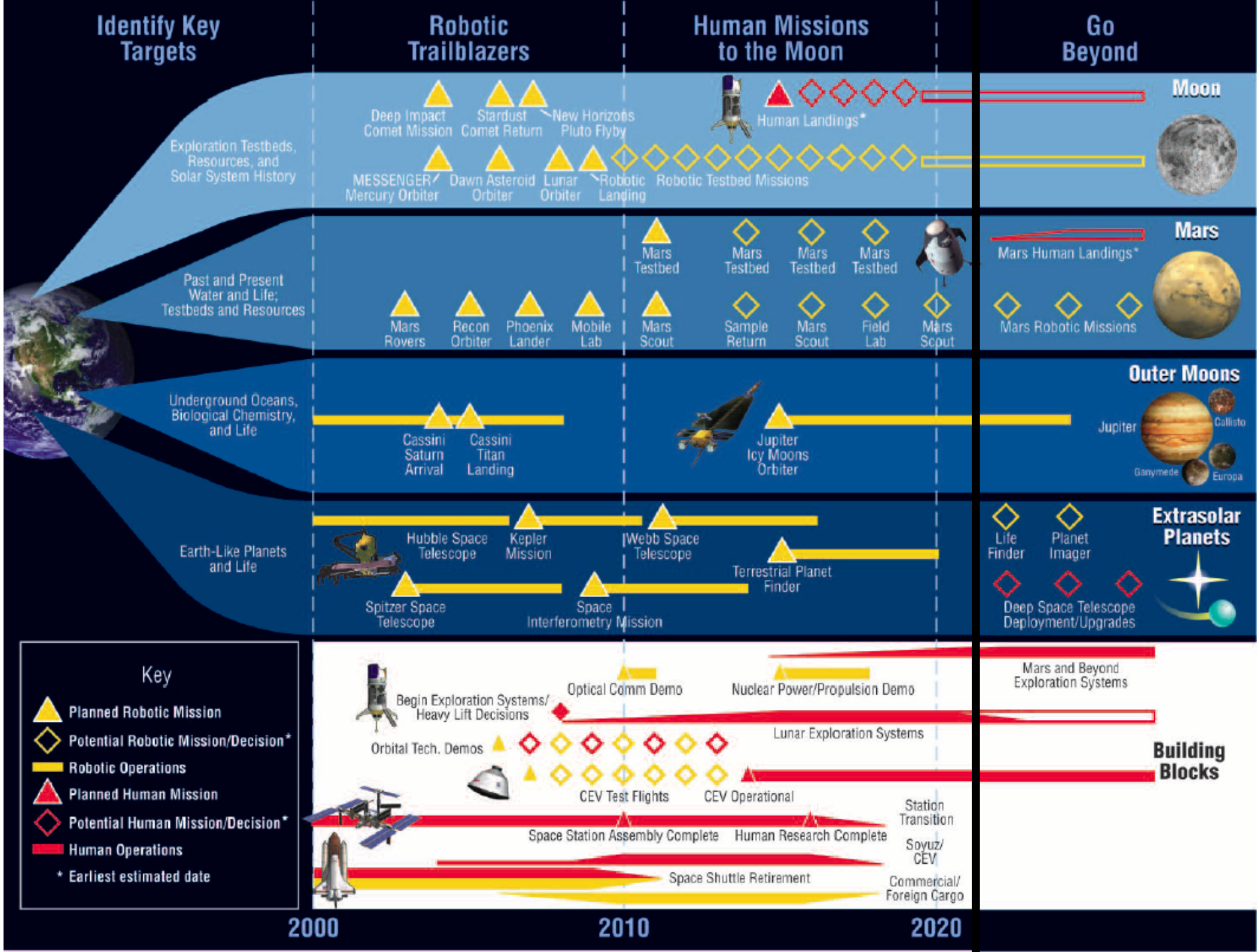
We’re going back…





The President's Vision (Goals & Objectives)

- Implement a sustained and affordable human and robotic program to explore the solar system and beyond
- Extend human presence across the solar system, starting with a human return to the Moon by the year 2020, in preparation for human exploration of Mars and other destinations
- Develop the innovative technologies, knowledge, and infrastructures both to explore and to support decisions about the destinations for human exploration
- Promote international and commercial participation in exploration to further U.S. scientific, security, and economic interests


Identify Key Targets
Robotic Trailblazers
Human Missions to the Moon
Go Beyond
Exploration Testbeds, Resources, and Solar System History
Deep Impact Comet Mission
Stardust Comet Return
New Horizons Pluto Flyby
Human Landings*
MESSENGER Mercury Orbiter
Dawn Asteroid Orbiter
Lunar Orbiter
Robotic Landing
Robotic Testbed Missions
Moon
Past and Present Water and Life; Testbeds and Resources
Mars Testbed
Mars Rovers
Recon Orbiter
Phoenix Lander
Mobile Lab
Mars Scout
Sample Return
Field Lab
Mars Human Landings*
Mars Robotic Missions
Mars
Underground Oceans, Biological Chemistry, and Life
Cassini Saturn Arrival
Cassini Titan Landing
Jupiter Icy Moons Orbiter
Outer Moons
Jupiter
Callisto
Ganymede
Europa
Earth-Like Planets and Life
Hubble Space Telescope
Kepler Mission
Webb Space Telescope
Terrestrial Planet Finder
Spitzer Space Telescope
Space Interferometry Mission
Life Finder
Planet Imager
Deep Space Telescope Deployment/Upgrades
Extrasolar Planets
Key
Planned Robotic Mission
Potential Robotic Mission/Decision*
Robotic Operations
Planned Human Mission
Potential Human Mission/Decision*
Human Operations
* Earliest estimated date
Begin Exploration Systems/ Heavy Lift Decisions
Optical Comm Demo
Nuclear Power/Propulsion Demo
Mars and Beyond Exploration Systems
Lunar Exploration Systems
Orbital Tech. Demos
Building Blocks
CEV Test Flights
CEV Operational
Station Transition
Space Station Assembly Complete
Human Research Complete
Soyuz/ CEV
Space Shuttle Retirement
Commercial/ Foreign Cargo
2000
2010
2020

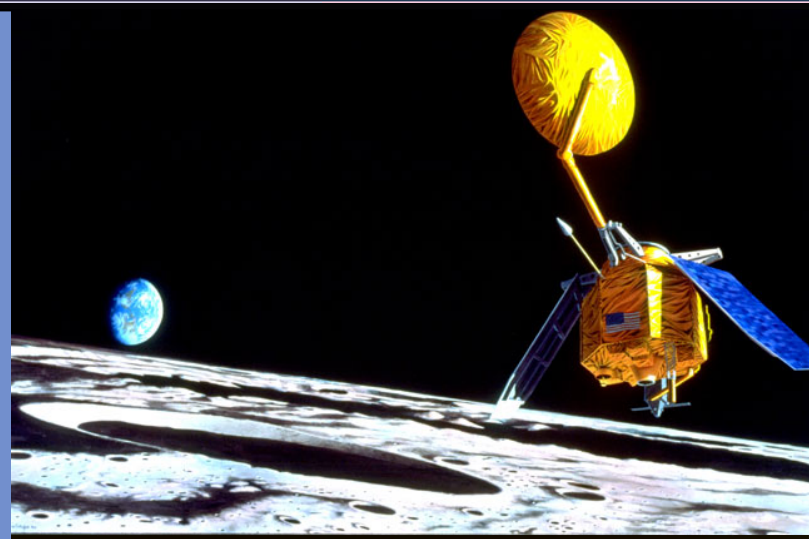
Lunar Exploration

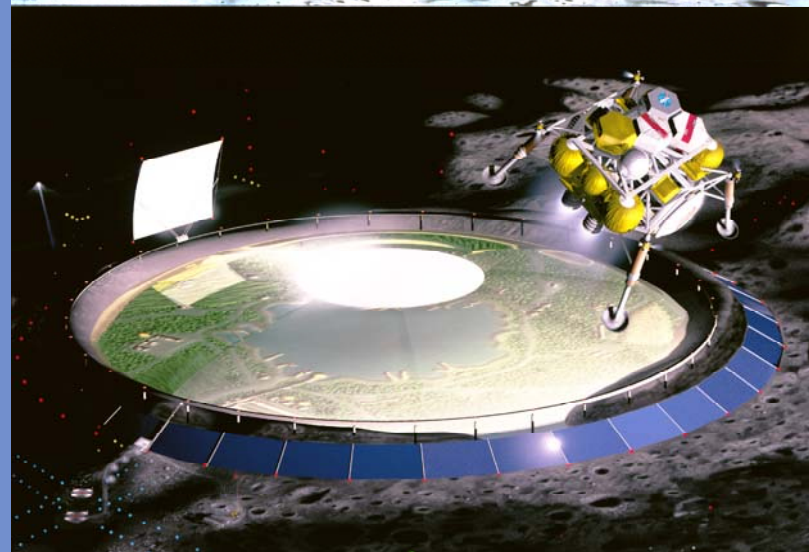
- Undertake lunar exploration activities to enable sustained human and robotic exploration of Mars and more distant destinations in the solar system

- Starting no later than 2008, initiate a series of robotic missions to the Moon to prepare for and support future human exploration activities

- Conduct the first extended human expedition to the lunar surface as early as 2015, but no later than the year 2020

- Use lunar exploration activities to further science, and to develop and test new approaches, technologies, and systems, including use of lunar and other space resources, to support sustained human space exploration to Mars and other destinations





Robotic Lunar Exploration

"Starting no later than 2008, initiate a series of robotic missions to the Moon to prepare for and support future human exploration activities"

- The Vision for Space Exploration, February 2004

Robotic Lunar Exploration Program

- A series of orbiters, probes, and landers… approximately 1/year through 2020, starting in 2008… that will systematically reduce the cost and risk of human exploration

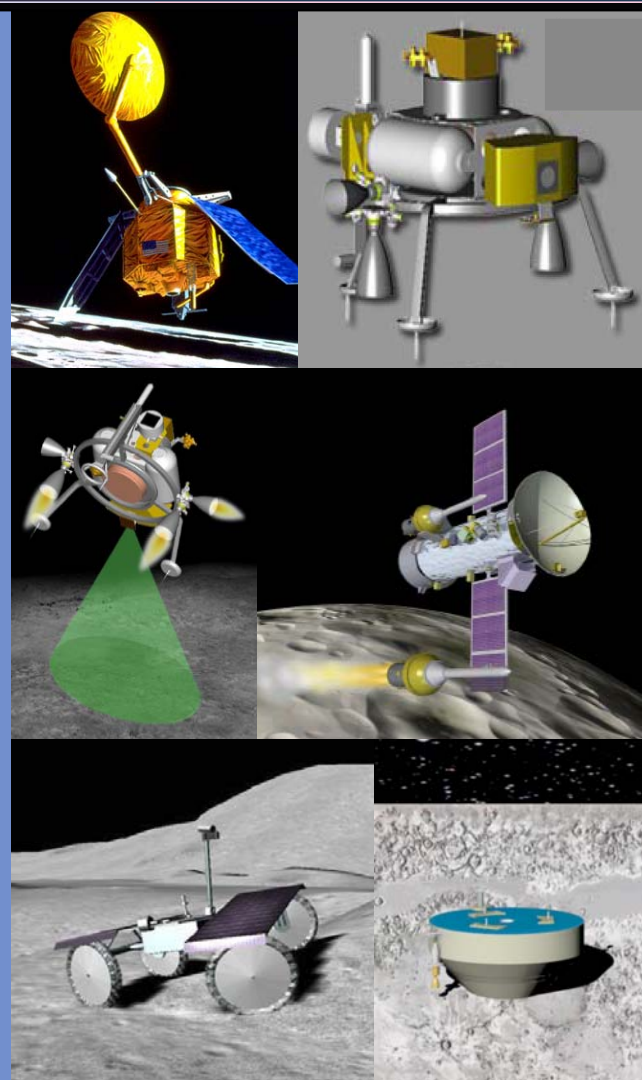
  – Global topography, lighting, and thermal mapping, plus targeted detailed topography mapping to support site selection and safety

  – Characterization of the lunar environment and its biological impacts (including radiation, dust, thermal, and partial gravity)

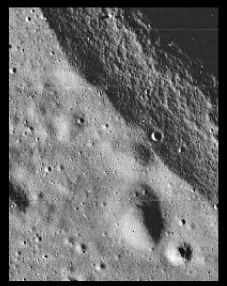
  – Resource prospecting and assessment of ISRU (in-situ resource utilization) and other technologies for use in human exploration

  – Refinement of gravity models to support auto-navigation and demonstration of autonomous precision landing on lunar surface

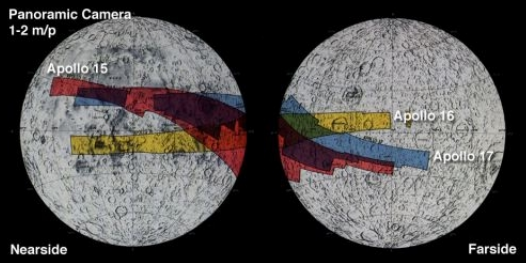
  – Establishment of any necessary communications, navigation, and power infrastructure for future robotic and human missions



2008 Lunar Reconnaissance Orbiter (LRO):
First Step in the Robotic Lunar Exploration Program

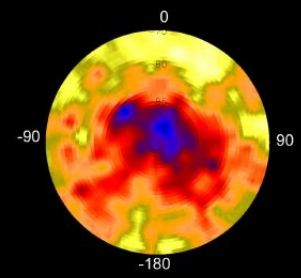


Lunar Orbiter camera

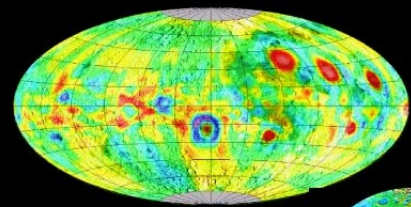


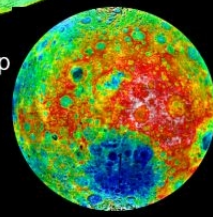
Apollo PanCam

Galileo multispectral imaging of 60% surface



Lunar Prospector elemental mapping





Clementine gravity map & topography

Objective: The Lunar Reconnaissance Orbiter (LRO) mission objective is to conduct investigations that will be specifically targeted to prepare for and support future human exploration of the Moon.

2008 Lunar Reconnaissance Orbiter (LRO):
First Step in the Robotic Lunar Exploration Program

- Total mass of ~1000 kg will be launched by a Delta-II class ELV into a direct lunar transfer orbit; ~100 kg will be instrumentation

- Primary mission of at least 1 year in circular polar mapping orbit (nominal 50 km altitude) with various extended mission options

<u>Solicited Measurement Investigations</u>

– Characterization and mitigation of lunar and deep space radiation environments and their impact on human-relatable biology

– Assessment of sub-meter scale features at potential landing sites

– High resolution global geodetic grid and topography

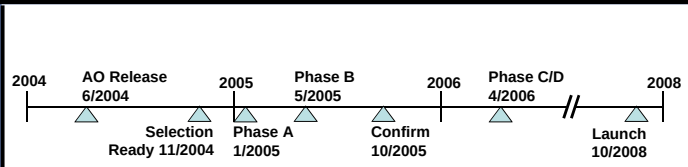
– Temperature mapping in polar shadowed regions

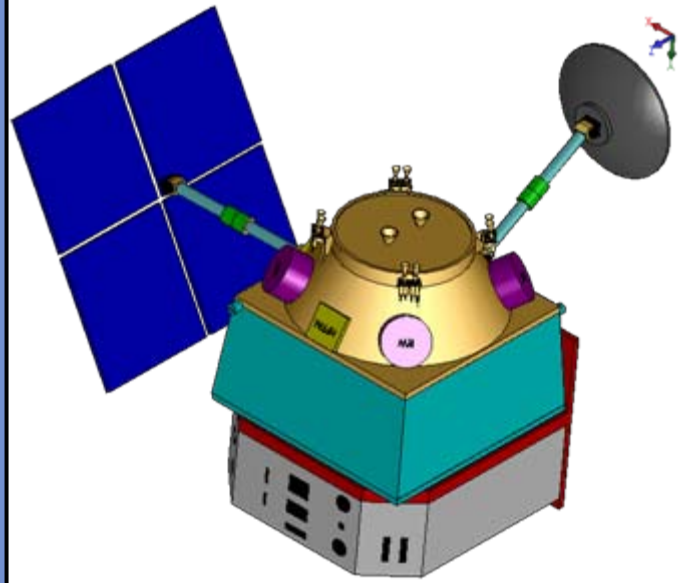
– Imaging of the lunar surface in permanently shadowed regions

– Identification of any appreciable near-surface water ice deposits in the polar cold traps

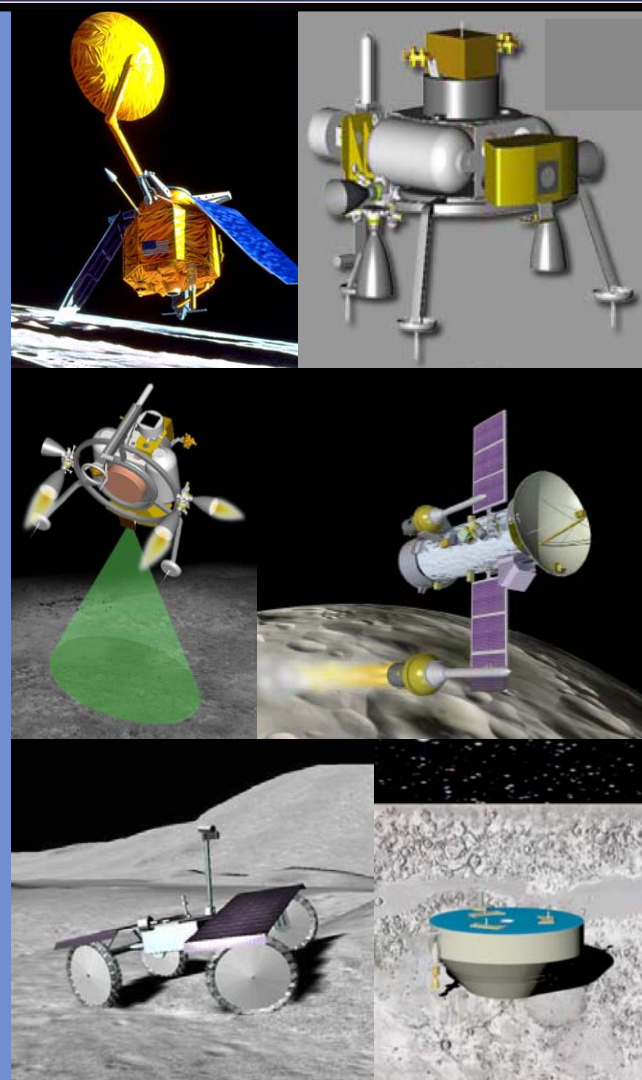
– High spatial resolution hydrogen mapping and assessment of ice

– Characterization of the changing surface illumination conditions in polar regions at time scales as short as hours





- LRO is the first step for the Robotic Lunar Exploration Program
- The second mission (2009/10) will likely have surface element(s)
  - may provide ground-truth for LRO resource findings (ice, etc.)
  - may carry radiation/biology experiments to the surface if ready
- A second “reconnaissance orbiter” will carry instrumentation that either did not fit on LRO, or could not be ready in time for LRO
- Program architecture will remain flexible in order to incorporate new data, science findings, and technology development efforts
- Effort will be made to avoid duplication with existing or planned international missions; data-sharing arrangements will be sought



Human Lunar Exploration

"Conduct the first extended human expedition to the lunar surface as early as 2015, but no later than the year 2020"

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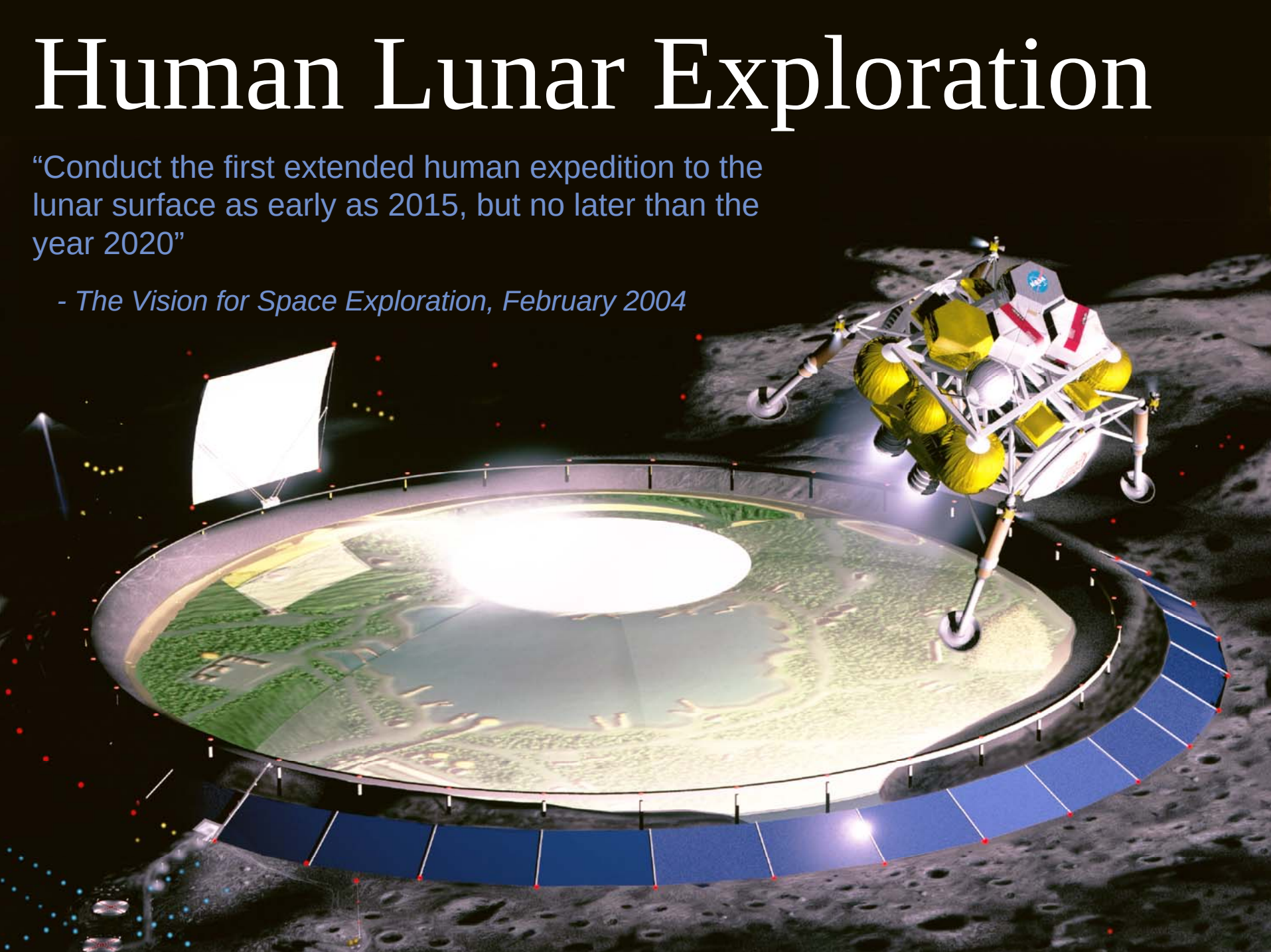

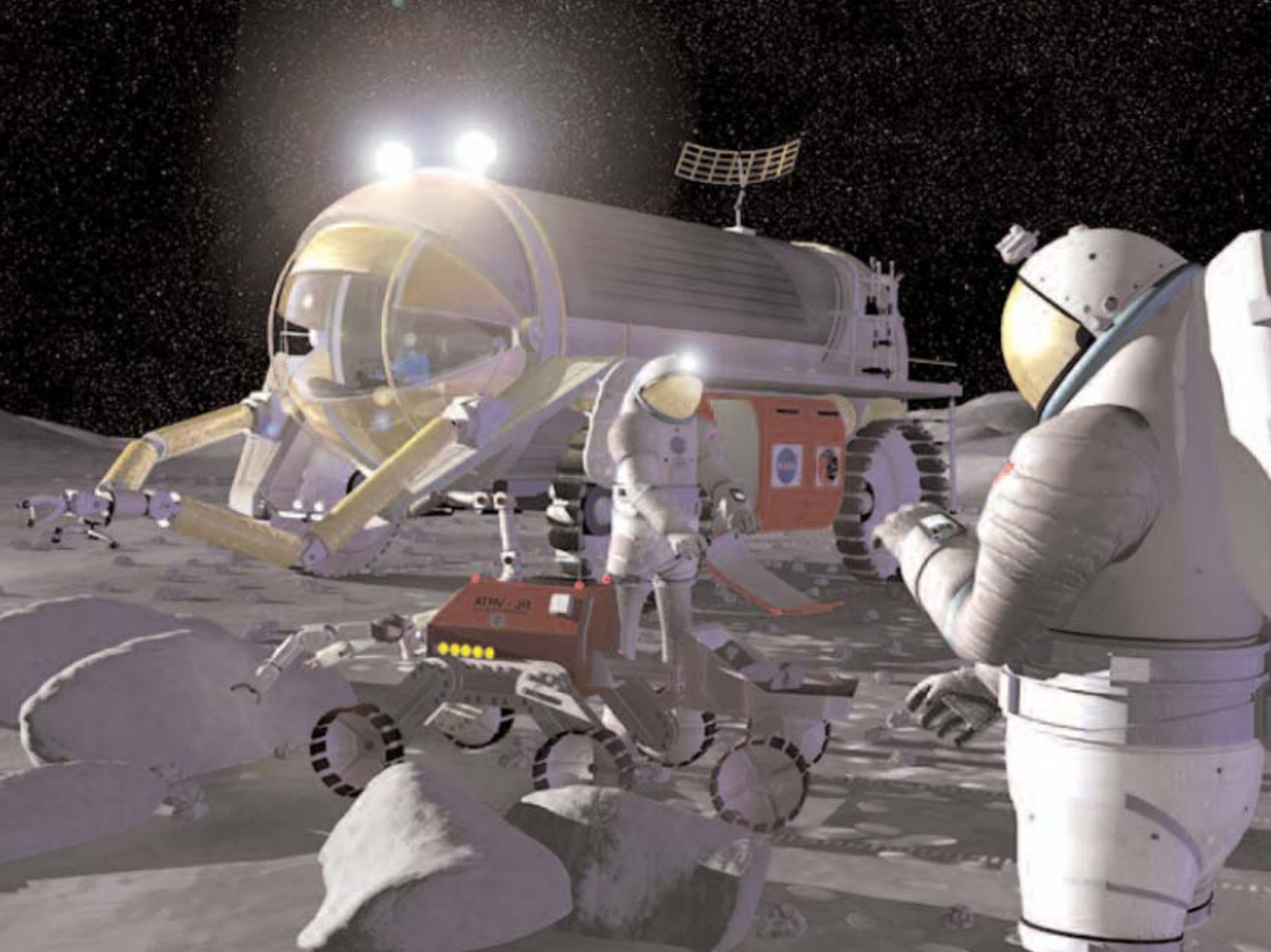

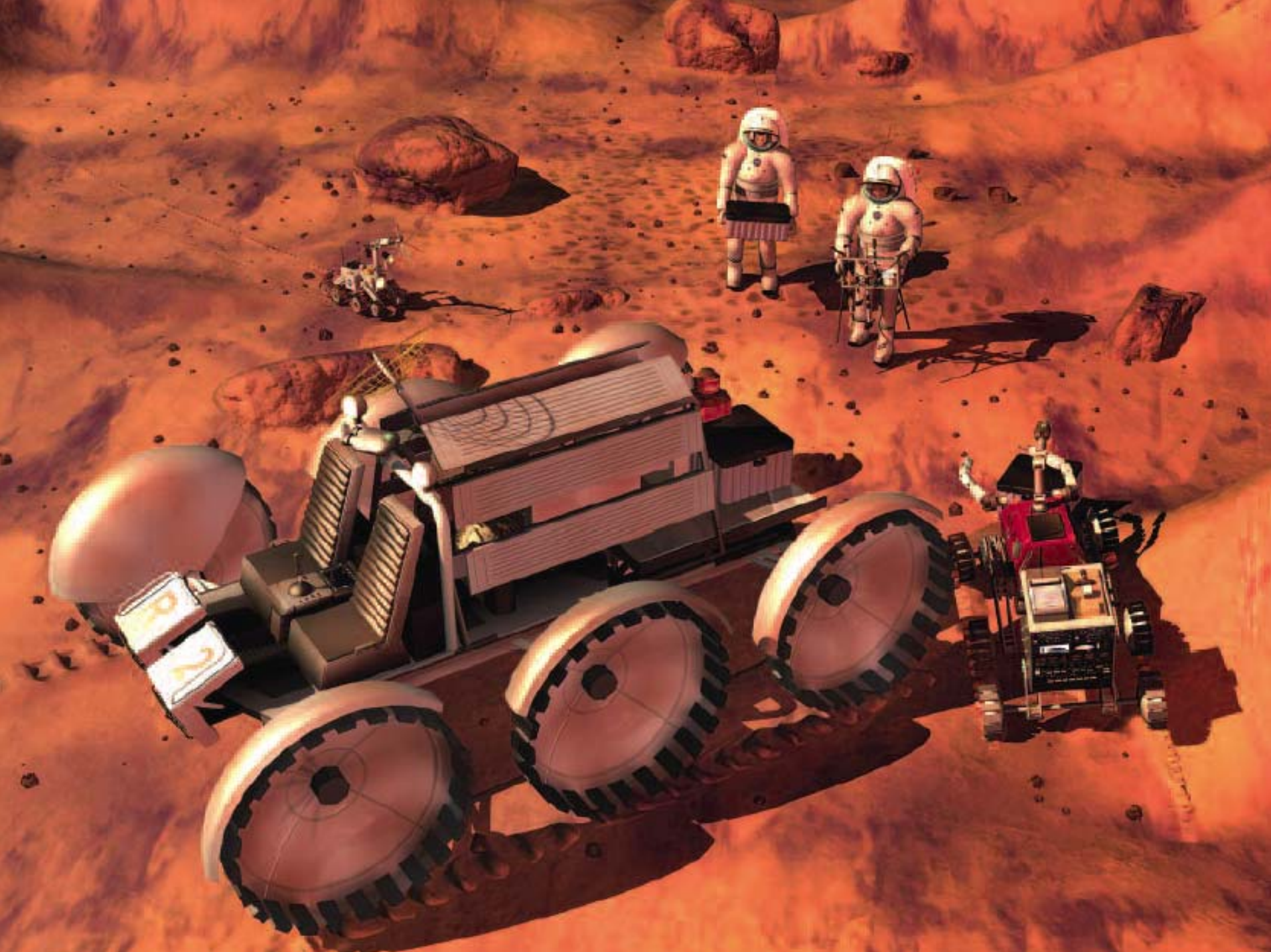
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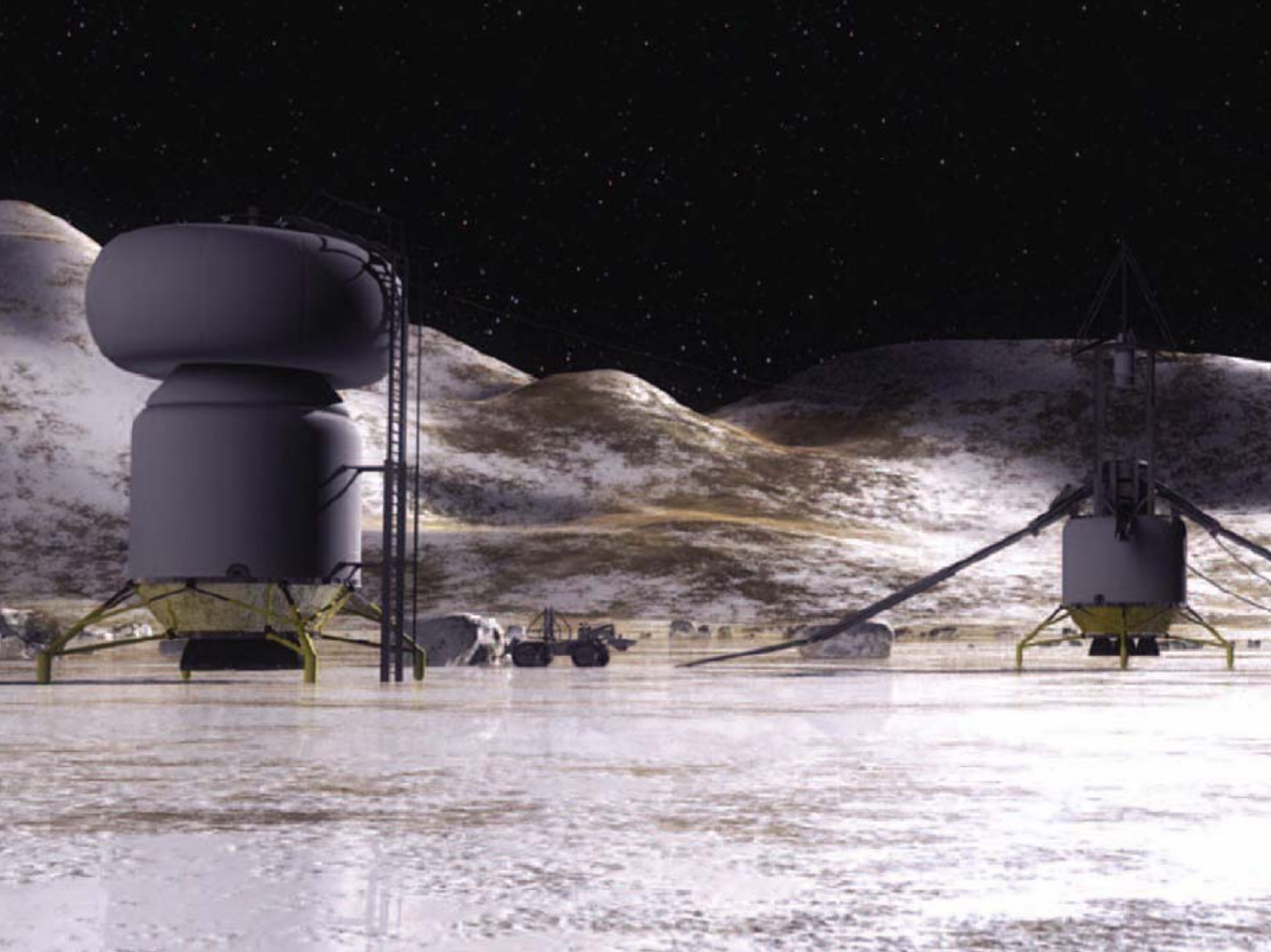

"Somewhere, something incredible is waiting to be known."
- Carl Sagan (1934-1996)

Let's explore…