National Aeronautics and Space Administration

NASA

Planets and Asteroids and Moons…OH MY!



EXPLORE SCIENCE

Eric E. Ianson

Deputy Director, Planetary Science Division

Director, Mars Exploration Program

NASA Headquarters

Shine Dome, Canberra, Australia

12 July 2024

NASA's Key Science Themes

PROTECT & IMPROVE LIFE ON EARTH & IN SPACE

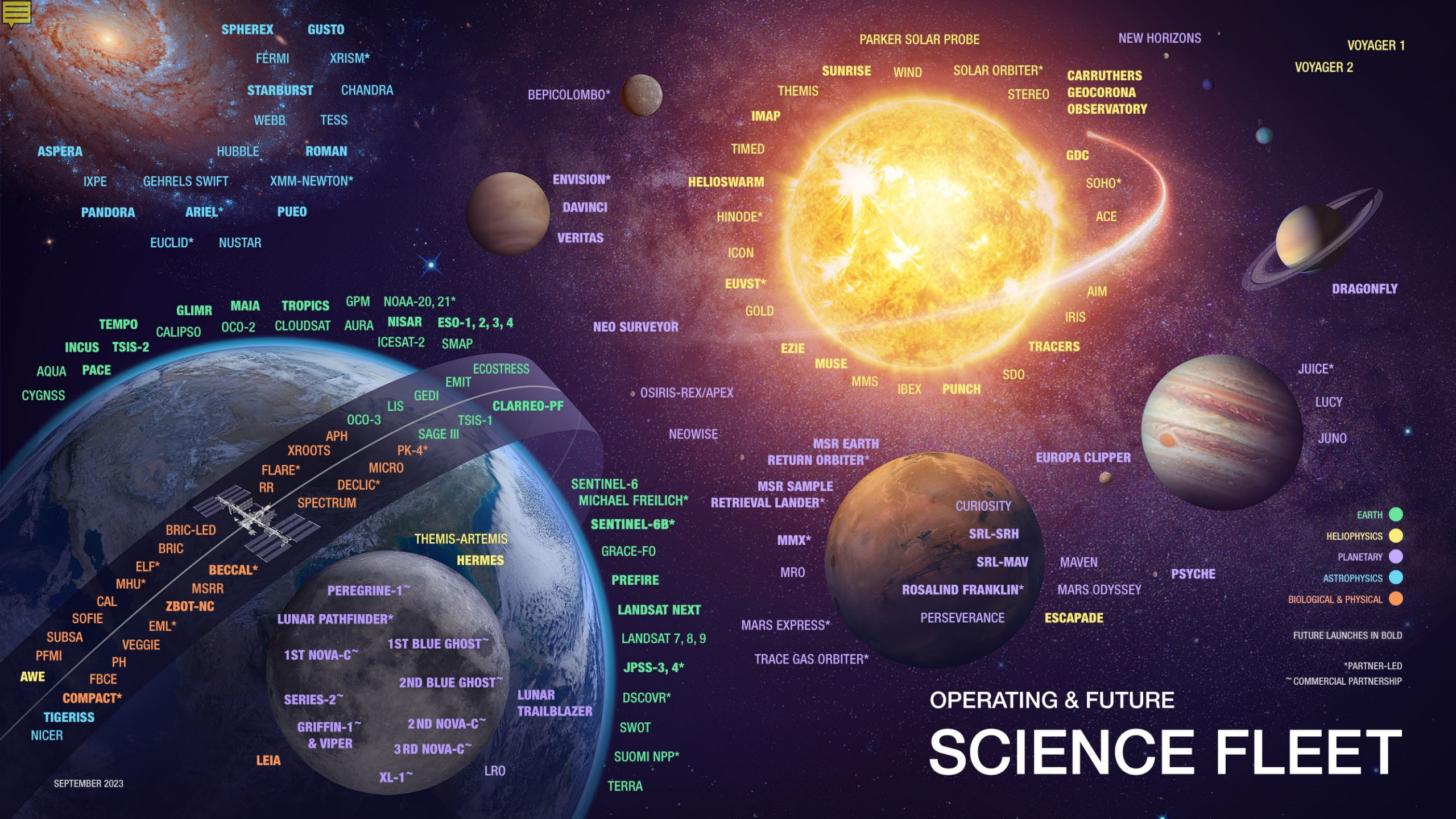


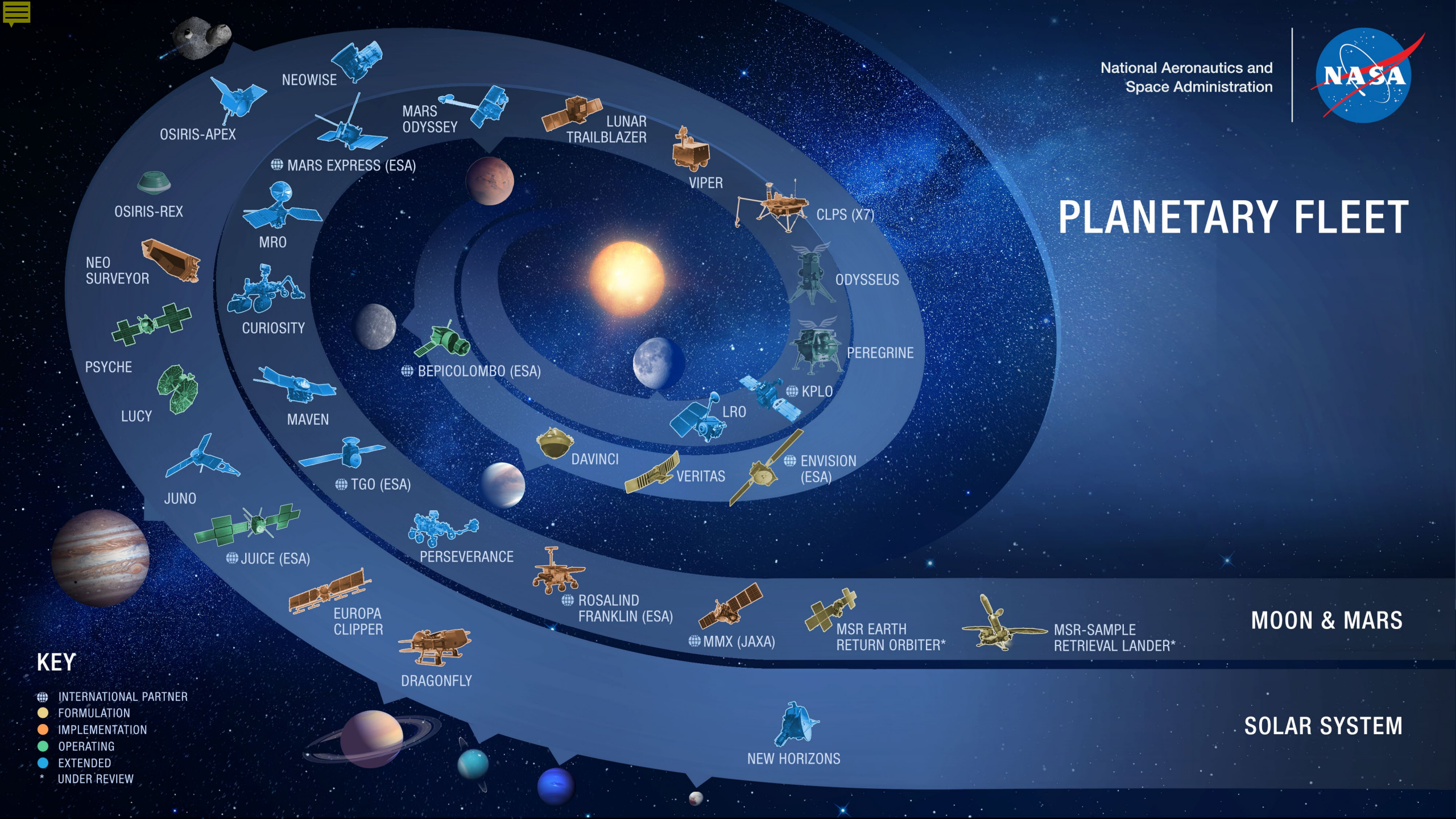
SEARCH FOR LIFE ELSEWHERE



DISCOVER SECRETS OF THE UNIVERSE




SPHEREX
GUSTO
FERMI
XRISM*
STARBURST
CHANDRA
WEBB
TESS
ASPERA
HUBBLE
ROMAN
IXPE
GEHRELS SWIFT
XMM-NEWTON*
PANDORA
ARIEL*
PUEO
EUCLID*
NUSTAR
BEPICOLOMBO*
ENVISION*
DAVINCI
VERITAS
PARKER SOLAR PROBE
NEW HORIZONS
VOYAGER 1
VOYAGER 2
SUNRISE
WIND
SOLAR ORBITER*
CARRUTHERS GEOCORONA OBSERVATORY
THEMIS
STEREO
IMAP
TIMED
HELIOSWARM
HINODE*
ICON
EUVST*
GOLD
GDC
SOHO*
ACE
AIM
IRIS
TRACERS
DRAGONFLY
NEO SURVEYOR
EZIE
MUSE
MMS
IBEX
PUNCH
SDO
OSIRIS-REX/APEX
NEOWISE
JUICE*
LUCY
JUNO
EUROPA CLIPPER
MSR EARTH RETURN ORBITER*
MSR SAMPLE RETRIEVAL LANDER*
MMX*
MRO
MARS EXPRESS*
TRACE GAS ORBITER*
CURIOSITY
SRL-SRH
SRL-MAV
ROSALIND FRANKLIN*
PERSEVERANCE
MAVEN
MARS ODYSSEY
ESCAPADE
PSYCHE
GLIMR
MAIA
TROPICS
GPM
NOAA-20, 21*
TEMPO
CALIPSO
OCO-2
CLOUDSAT
AURA
NISAR
ESO-1, 2, 3, 4
ICESAT-2
SMAP
INCUS
TSIS-2
AQUA
PACE
CYGNSS
ECOSTRESS
EMIT
GEDI
LIS
CLARREO-PF
OCO-3
TSIS-1
APH
SAGE III
XROOTS
PK-4*
FLARE*
MICRO
RR
DECLIC*
SPECTRUM
BRIC-LED
BRIC
ELF*
BECCAL*
MHU*
MSRR
CAL
ZBOT-NC
SOFIE
EML*
SUBSA
VEGGIE
PFMI
PH
AWE
FBCE
COMPACT*
TIGERISS
NICER
SENTINEL-6 MICHAEL FREILICH*
SENTINEL-6B*
GRACE-FO
PREFIRE
LANDSAT NEXT
LANDSAT 7, 8, 9
JPSS-3, 4*
DSCOVR*
SWOT
SUOMI NPP*
TERRA
THEMIS-ARTEMIS
HERMES
PEREGRINE-1~
LUNAR PATHFINDER*
1ST BLUE GHOST~
1ST NOVA-C~
2ND BLUE GHOST~
SERIES-2~
LUNAR TRAILBLAZER
GRIFFIN-1~ & VIPER
2ND NOVA-C~
3RD NOVA-C~
LEIA
XL-1~
LRO
EARTH
HELIOPHYSICS
PLANETARY
ASTROPHYSICS
BIOLOGICAL & PHYSICAL
FUTURE LAUNCHES IN BOLD
*PARTNER-LED
~ COMMERCIAL PARTNERSHIP
OPERATING & FUTURE
SCIENCE FLEET
SEPTEMBER 2023

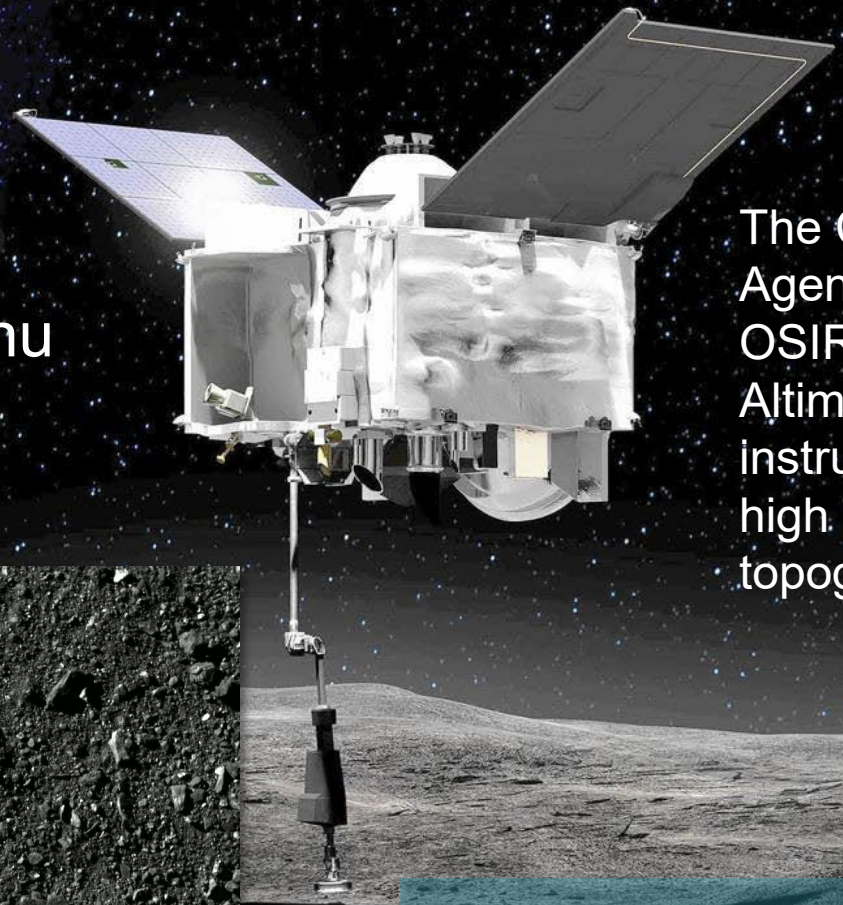

National Aeronautics and Space Administration
NASA
PLANETARY FLEET
NEOWISE
OSIRIS-APEX
MARS ODYSSEY
LUNAR TRAILBLAZER
MARS EXPRESS (ESA)
VIPER
CLPS (X7)
OSIRIS-REX
MRO
ODYSSEUS
NEO SURVEYOR
CURIOSITY
PEREGRINE
PSYCHE
BEPICOLOMBO (ESA)
KPLO
LUCY
LRO
MAVEN
DAVINCI
ENVISION (ESA)
TGO (ESA)
VERITAS
JUNO
JUICE (ESA)
PERSEVERANCE
ROSALIND FRANKLIN (ESA)
EUROPA CLIPPER
MMX (JAXA)
MSR EARTH RETURN ORBITER*
MSR-SAMPLE RETRIEVAL LANDER*
MOON & MARS
DRAGONFLY
NEW HORIZONS
SOLAR SYSTEM
KEY
INTERNATIONAL PARTNER
FORMULATION
IMPLEMENTATION
OPERATING
EXTENDED
* UNDER REVIEW

Recent Highlights

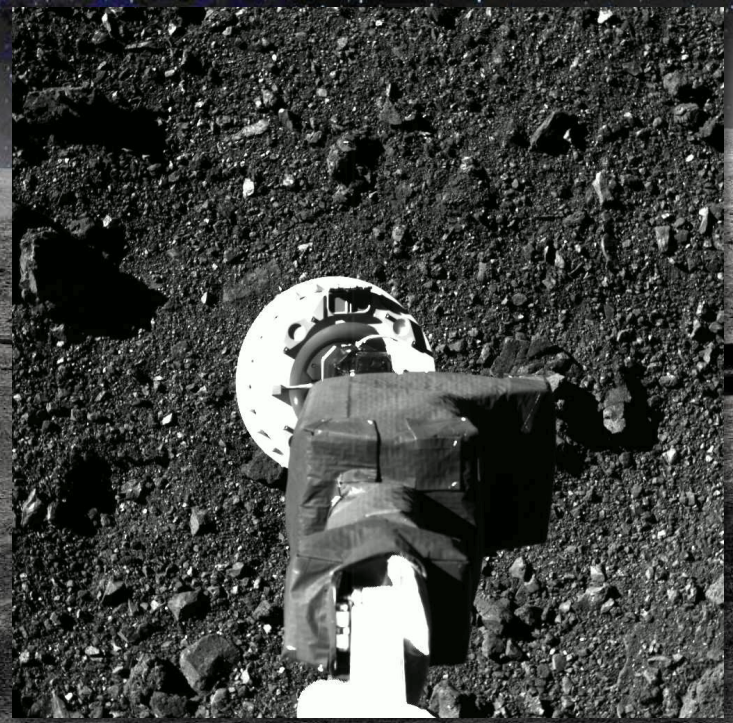


OSIRIS-REx

- Sample Collection from asteroid Bennu
- Touch-and-Go ('TAG') at Nightingale Crater: Oct 20, 2020

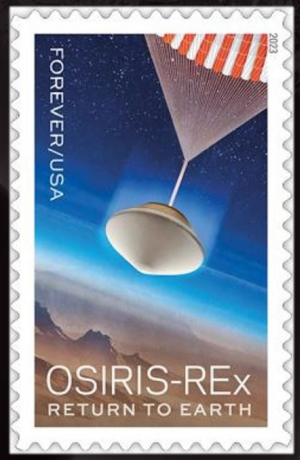


The Canadian Space Agency provided the OSIRIS-REx Laser Altimeter, a scanning & lida instrument that provided high resolution topographical information.



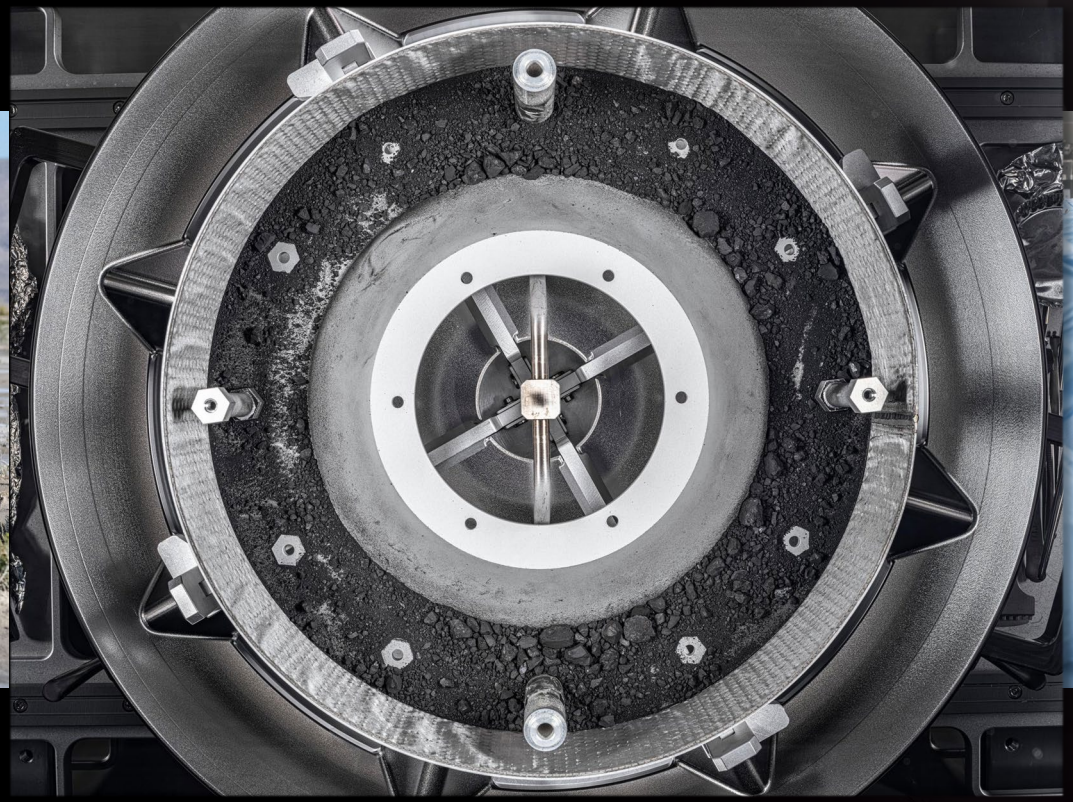
Samples landed at Utah Test and Training Range, September 24, 2023

OSIRIS-REX: To Bennu – and Back!



Sample catalog is out: https://curator.jsc.nasa.gov/osirisrex/index.cfm







Overview manuscript (in review) available on Arxiv: https://arxiv.org/abs/2404.12536

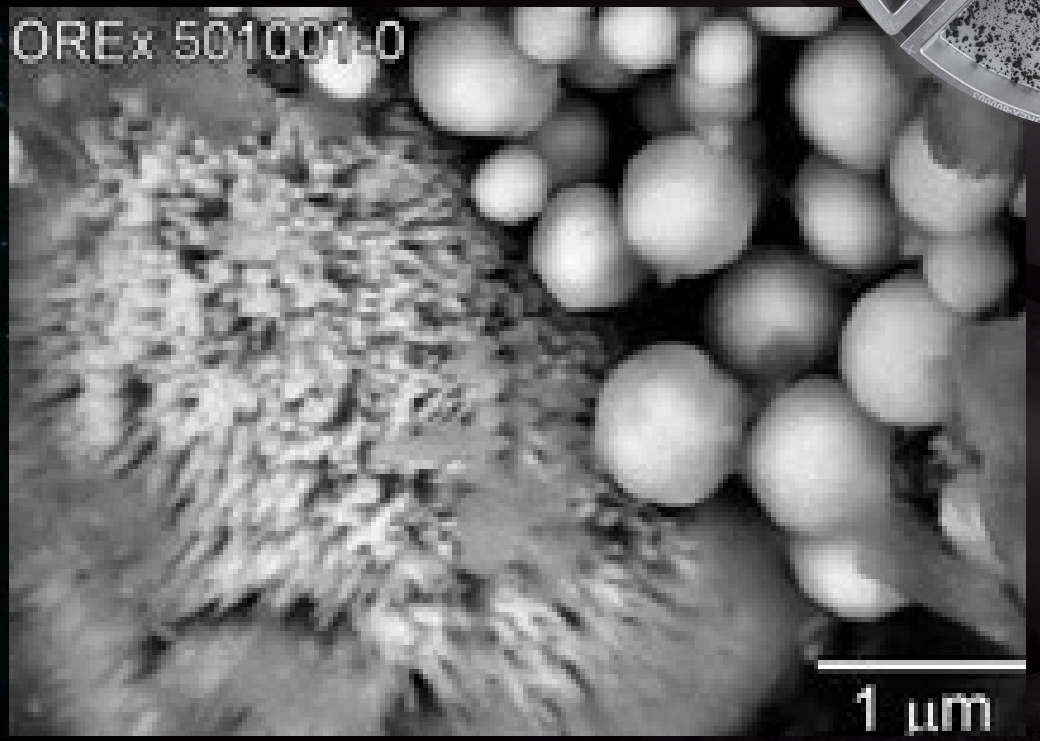
OSIRIS-REx: Sample Surprises

Sample catalog: https://curator.jsc.nasa.gov/osirisrex/index.cfm

Lauretta et al., 2024, Asteroid (101955) Bennu in the laboratory: Properties of the sample collected by OSIRIS-REx, *Meteoritics & Planetary Science* (doi:10.1111/maps.14227)







Top: *Bennu sample contained in eight trays*

Left: *Bennu particle (about 1 mm long) with crust of bright phosphate*

Right: *Magnetite spheres with radially projecting needles next to dodecahedral crystals*

DART

Double Asteroid Redirection Test

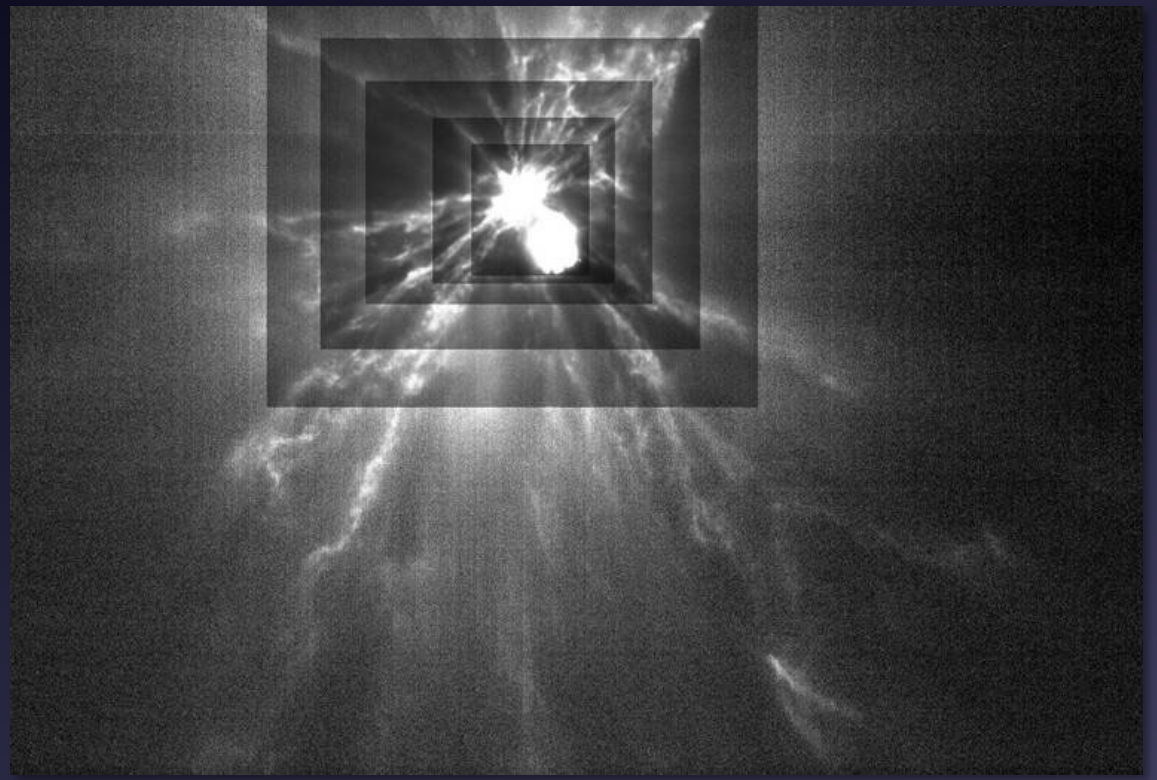
Before: 11 hr 55 min

After: 11 hr 22 min

Change: 33 mins!



Impact witnessed by ATLAS telescope



LICIACube image showing plumes of ejecta streaming from Dimorphos after impact

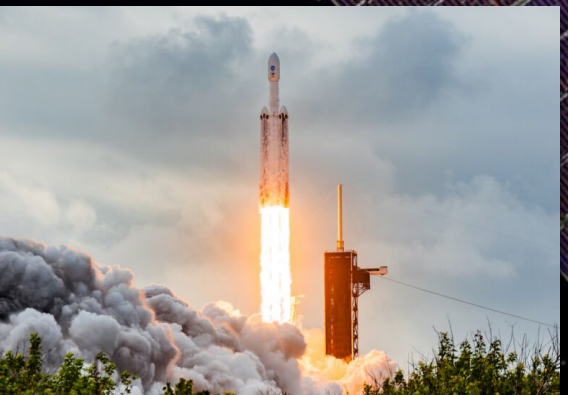
Psyche Mission

Launched: October 13, 2023

Psyche Orbit Insertion: August 2029

Orbital mission: ~26 months

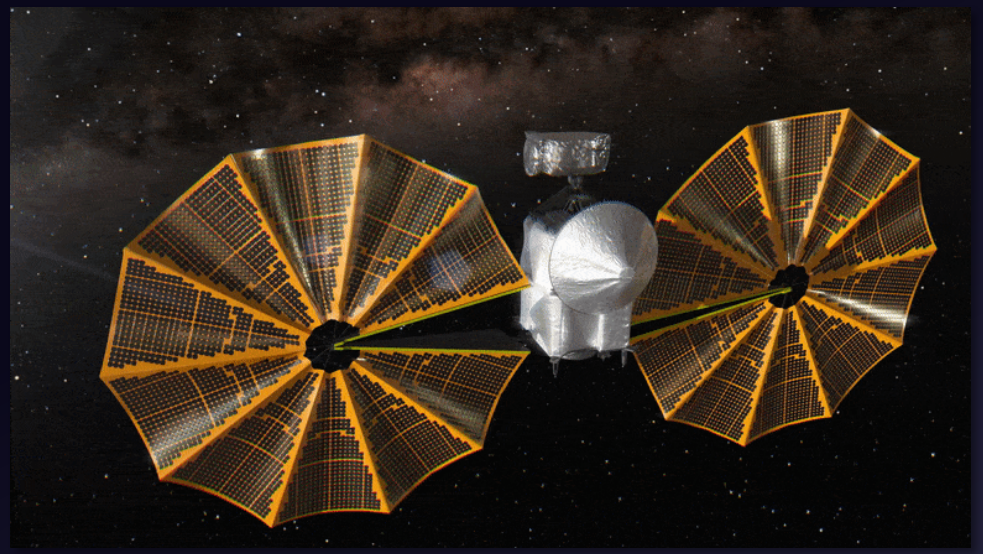
Deep Space Optical Communications Demo



What is this asteroid

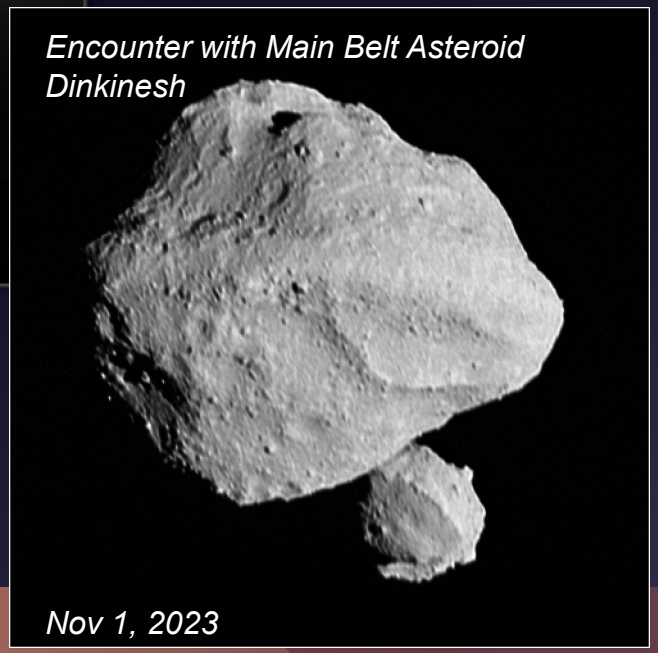
Asteroid Psyche appears to be the exposed nickel-iron core of an early planet, one of the building blocks of our solar system

Lucy





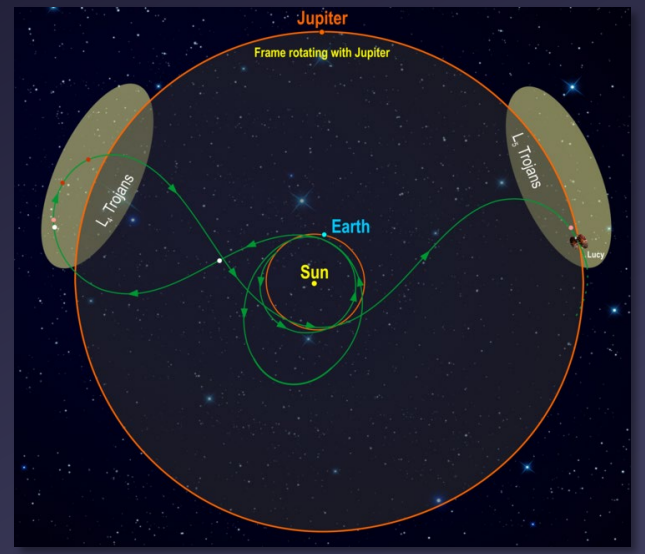
Lucy launch, Cape Canaveral, Oct 16, 2021



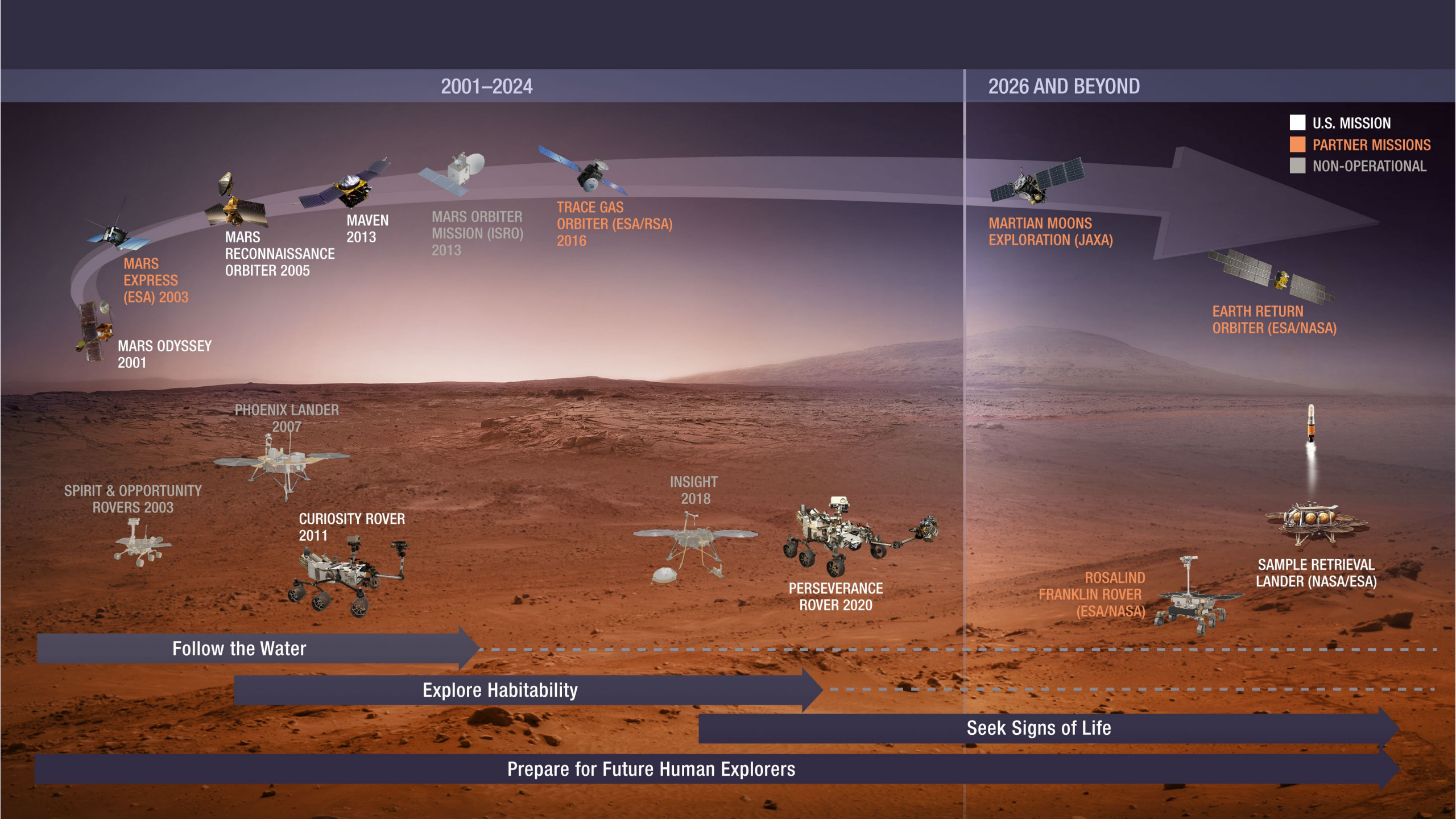
Encounter with Main Belt Asteroid Dinkinesh

Nov 1, 2023

- Launched: October 2021
- Observation Targets:
  - 1 Main Belt Asteroid
  - 6 Trojan Asteroids
- Mission Duration: 12 years




Let’s Talk Mars!


2001–2024
2026 AND BEYOND
U.S. MISSION
PARTNER MISSIONS
NON-OPERATIONAL
MARS EXPRESS (ESA) 2003
MARS RECONNAISSANCE ORBITER 2005
MAVEN 2013
MARS ORBITER MISSION (ISRO) 2013
TRACE GAS ORBITER (ESA/RSA) 2016
MARS ODYSSEY 2001
MARTIAN MOONS EXPLORATION (JAXA)
EARTH RETURN ORBITER (ESA/NASA)
PHOENIX LANDER 2007
SPIRIT & OPPORTUNITY ROVERS 2003
CURIOSITY ROVER 2011
INSIGHT 2018
PERSEVERANCE ROVER 2020
ROSALIND FRANKLIN ROVER (ESA/NASA)
SAMPLE RETRIEVAL LANDER (NASA/ESA)
Follow the Water
Explore Habitability
Seek Signs of Life
Prepare for Future Human Explorers

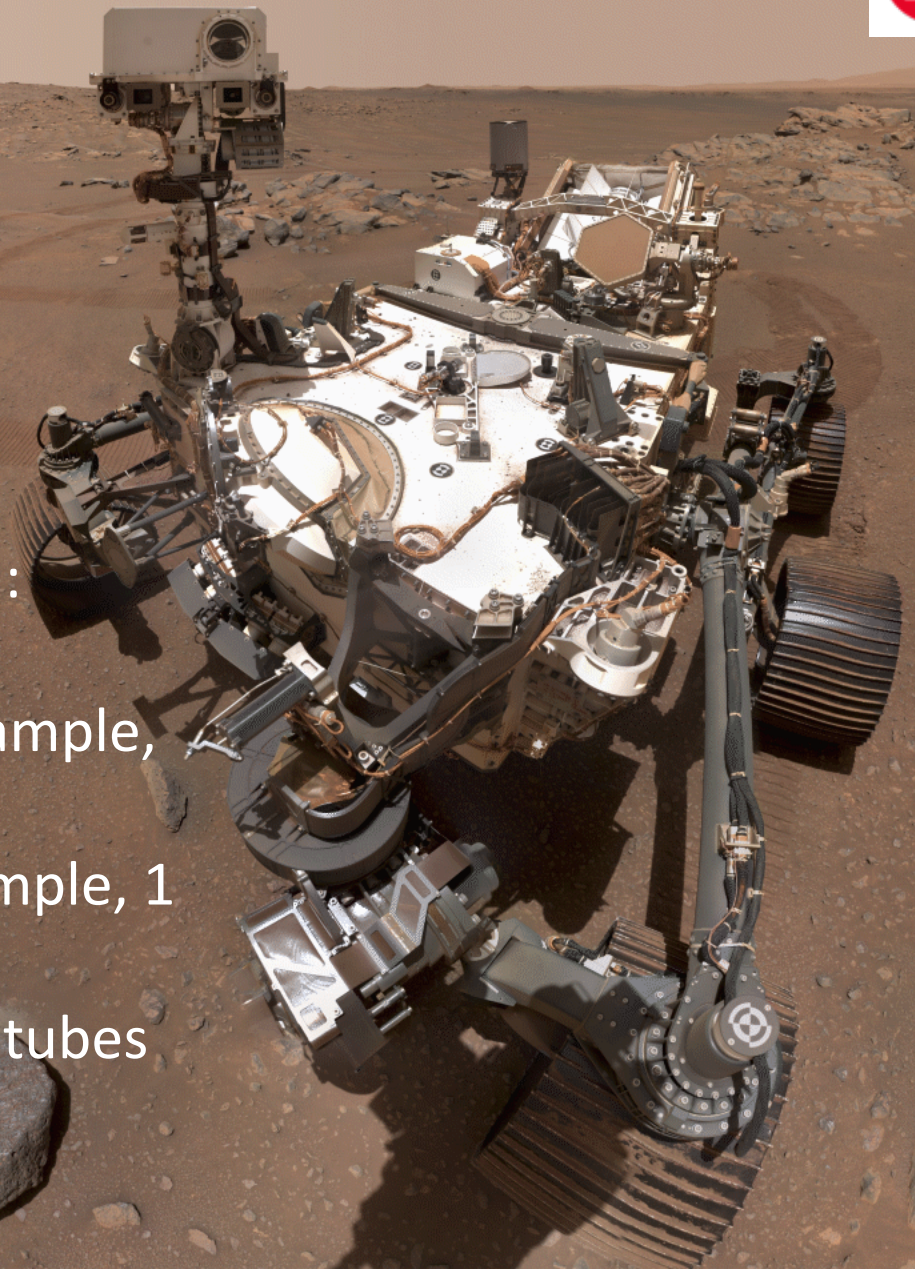
MSL Curiosity Rover

- Curiosity landed in Gale Crater in August 2012 and is exploring Mount Sharp (Aeolis Mons), a 3-mile-high mountain within the crater. The rover has completed 31 km of traverse, gained 760 meters in elevation, and analyzed 45 samples as of late 2023.
- The mission found that the crater floor and lower Mount Sharp formed in ancient rivers and lakes that contained carbon-based molecules that are necessary for life as we know it.
- Curiosity is currently exploring layers on Mount Sharp that formed during a time of dramatic change from wetter to drier conditions, with a goal of understanding the persistence of habitability.



MARS SCIENCE LABORATORY

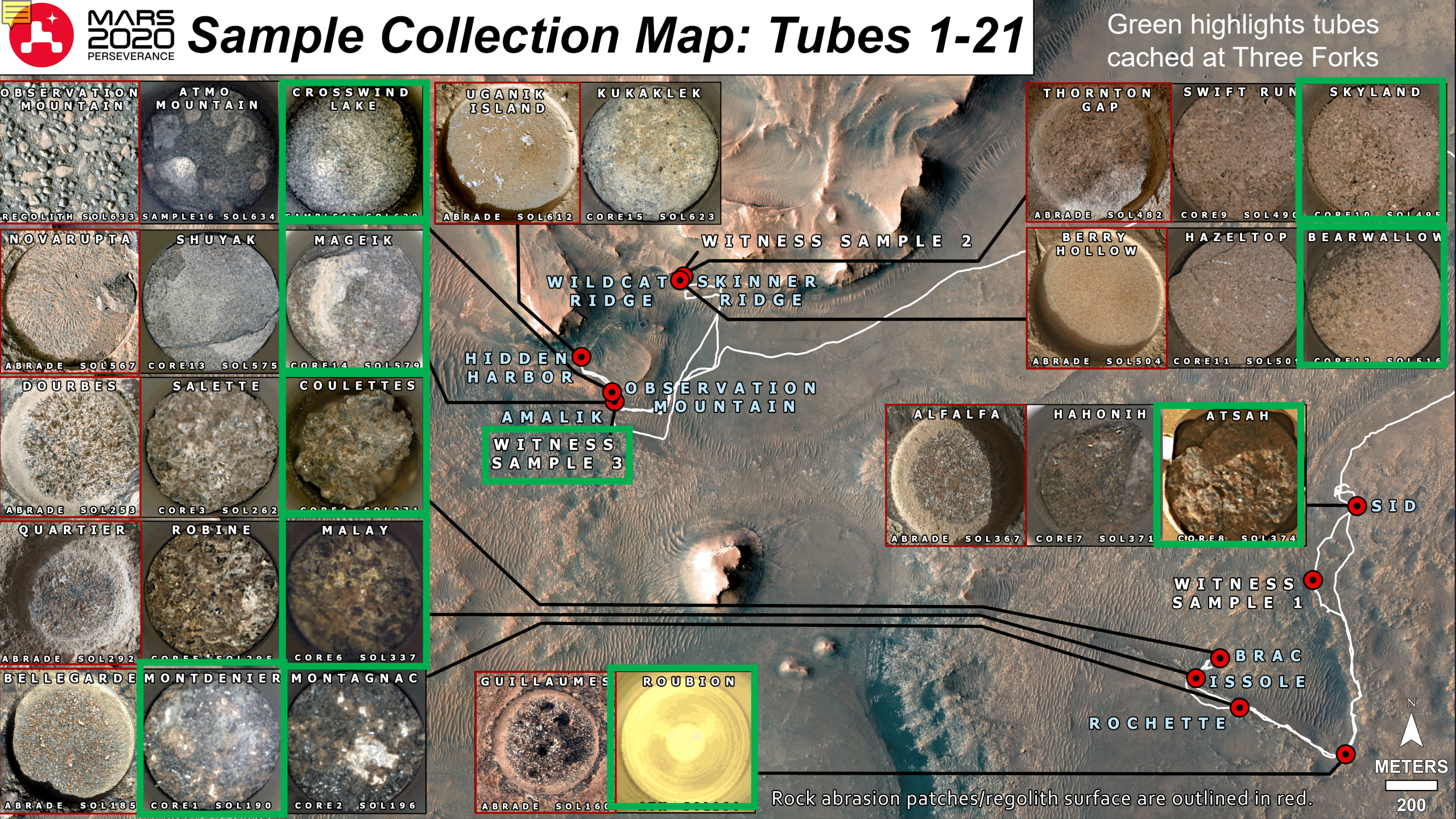
Mars Perseverance Rover



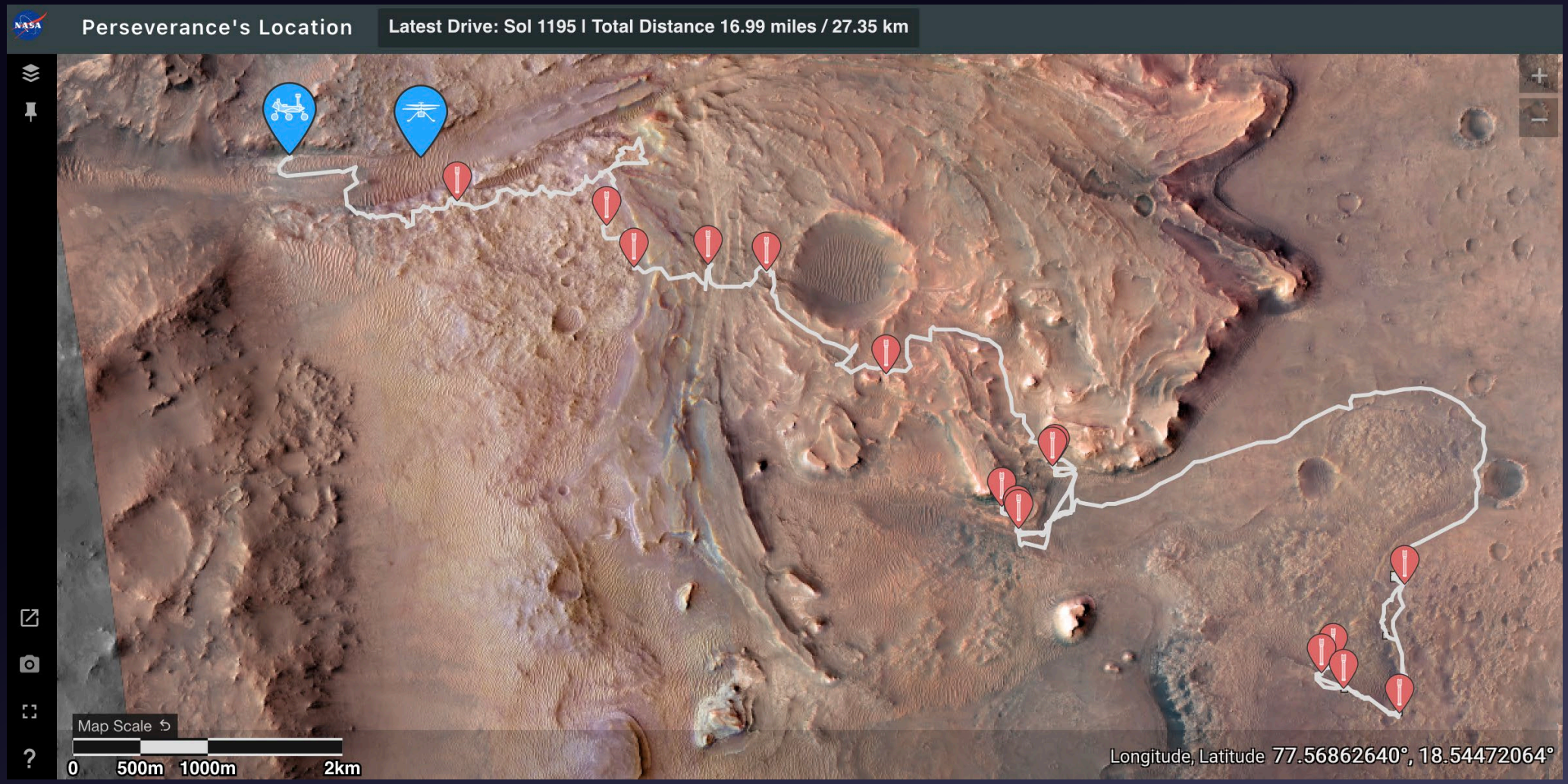
- Landed on Mars February 18, 2021
- Exploring Jezero Crater
- Taking Samples from Mars to return to Earth

Perseverance by the numbers (as of 9 July 2024):

- Rover Odometry: 28,502.3 meters
- On Rover Samples: 14 rock cores, 1 regolith sample, 2 witness tubes
- Three Forks Cache: 7 rock cores, 1 regolith sample, 1 atmospheric sample, 1 witness tube
- Remaining Tubes: 12 sample tubes, 2 witness tubes

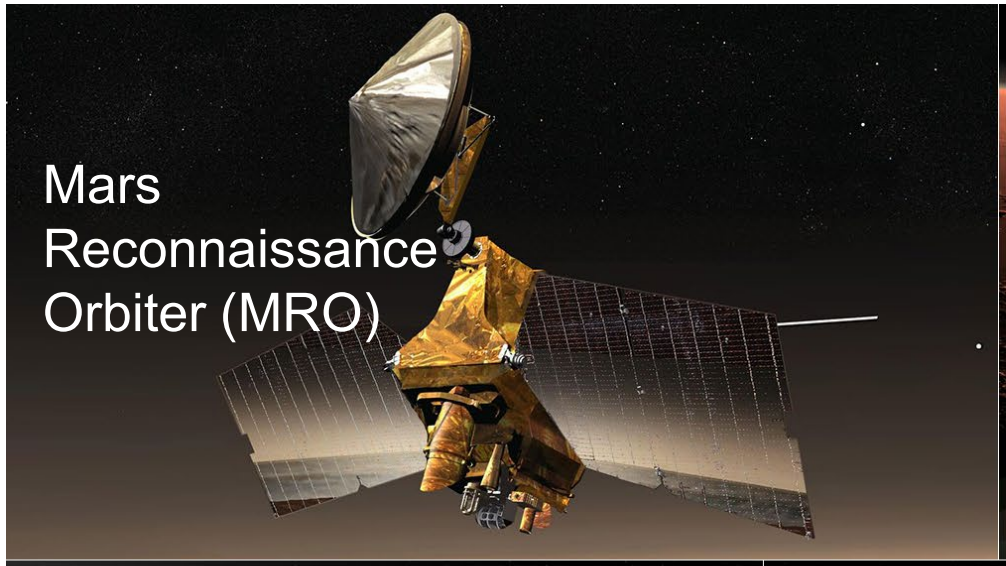

MARS 2020 PERSEVERANCE
Sample Collection Map: Tubes 1-21
Green highlights tubes cached at Three Forks
OBSERVATION MOUNTAIN
REGOLITH SOL633
ATMO MOUNTAIN
SAMPLE16 SOL634
CROSSWIND LAKE
UGANIK ISLAND
ABRADE SOL612
KUKAKLEK
CORE15 SOL623
THORNTON GAP
ABRADE SOL482
SWIFT RUN
CORE9 SOL490
SKYLAND
CORE10 SOL485
NOVARUPTA
ABRADE SOL567
SHUYAK
CORE13 SOL575
MAGEIK
CORE14 SOL579
WITNESS SAMPLE 2
WILDCAT RIDGE
SKINNER RIDGE
BERRY HOLLOW
ABRADE SOL504
HAZELTOP
CORE11 SOL509
BEARWALLOW
CORE12 SOL516
HIDDEN HARBOR
OBSERVATION MOUNTAIN
AMALIK
WITNESS SAMPLE 3
DOURBES
ABRADE SOL253
SALETTE
CORE3 SOL262
COULETTES
ALFALFA
ABRADE SOL367
HAHONIH
CORE7 SOL371
ATSAH
CORE8 SOL374
SID
QUARTIER
ABRADE SOL292
ROBINE
MALAY
CORE6 SOL337
WITNESS SAMPLE 1
BRAC
ISSOLE
ROCHETTE
BELLEGARDE
ABRADE SOL185
MONTDENIER
CORE1 SOL190
MONTAGNAC
CORE2 SOL196
GUILLAUMES
ABRADE SOL160
ROUBION
N
METERS
200
Rock abrasion patches/regolith surface are outlined in red.

Where is Perseverance?



Location as of 9 July 2024

Mars Orbiting Spacecraft











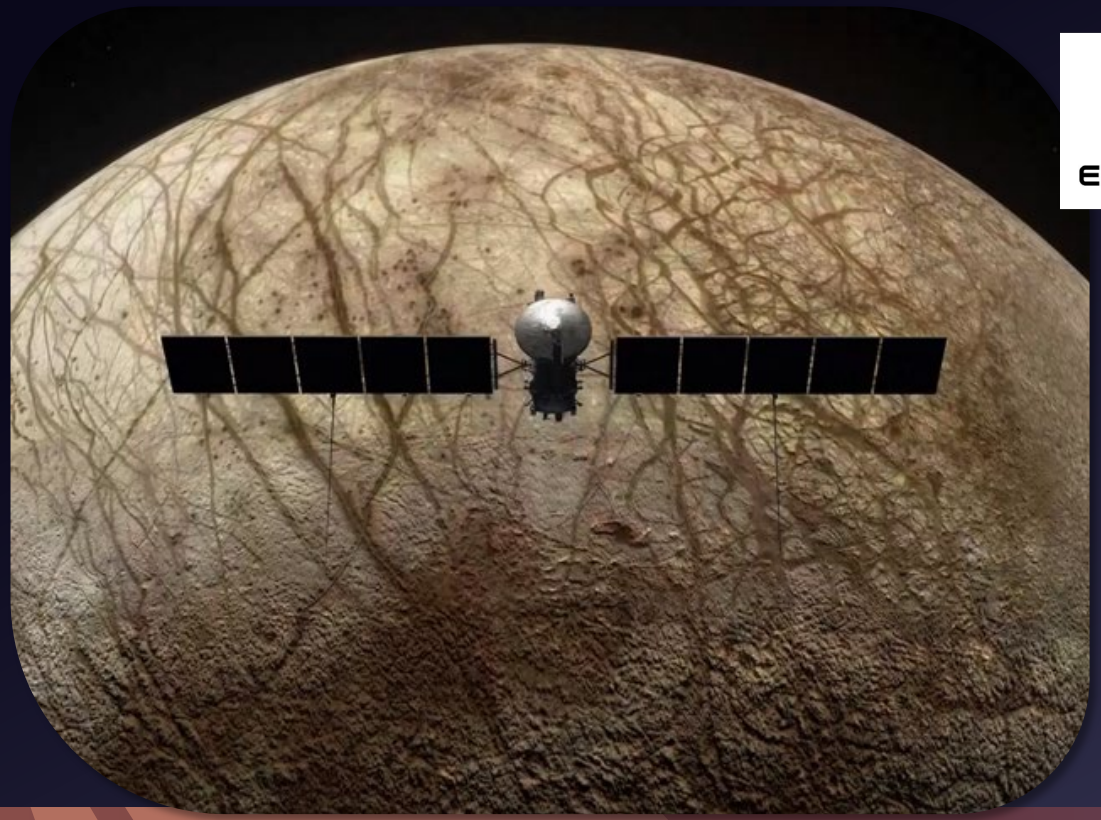
Orbiting spacecraft at Mars:

- Make global science measurements
- Provide information about the terrain and weather
- Relay information between Earth and Mars surface assets


Current and Future
Amazing Missions!

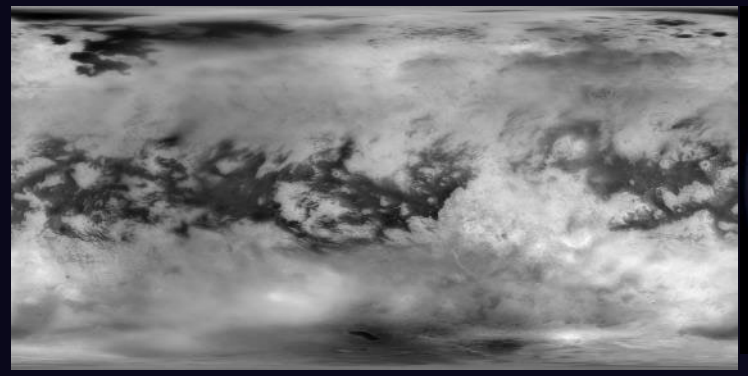
Europa Clipper

- Mission to Jupiter's moon, Europa, launching Oct 2024
- Overarching goal: determine if Europa has conditions suitable to support life
  - Contains all the ingredients: water, chemistry, energy

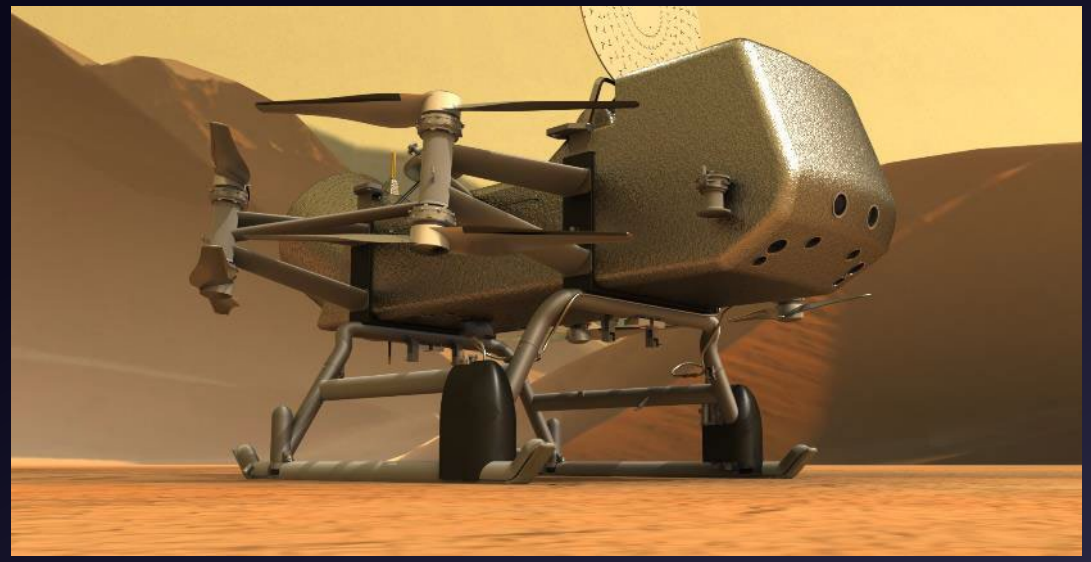




Dragonfly



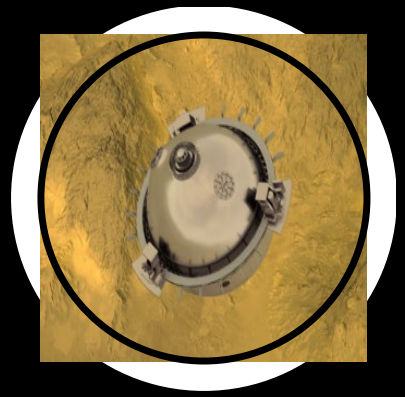






- Targeted Launch: June 2027
- Titan Arrival: 2034
- Rotorcraft lander w/science instrument suite

Return to Venus



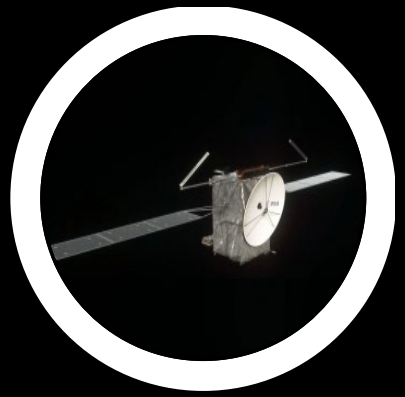
DAVINCI

Deep Atmosphere Venus Investigation of Noble Gases, Chemistry, and Imaging



VERITAS

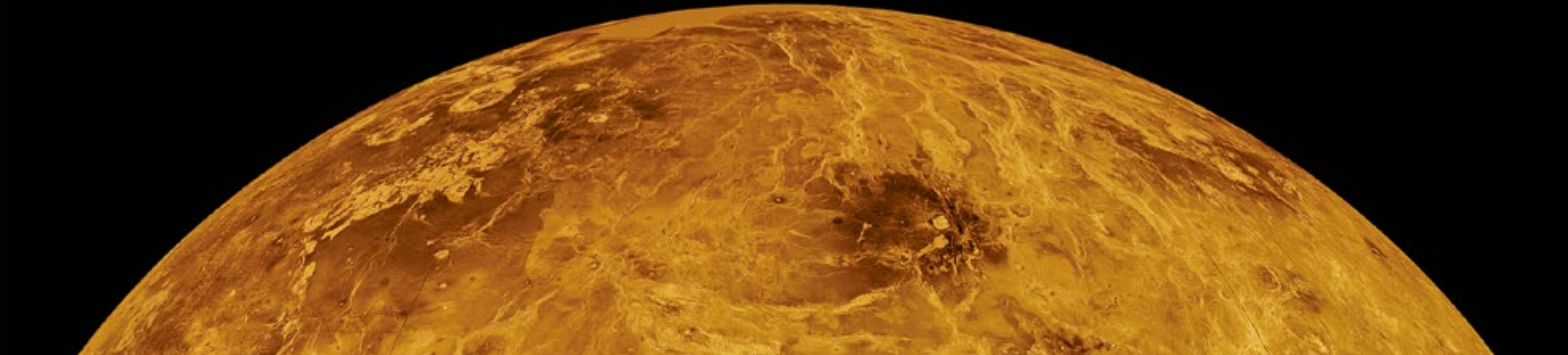
Venus Emissivity, Radio Science, InSAR, Topography, & Spectroscopy



EnVision

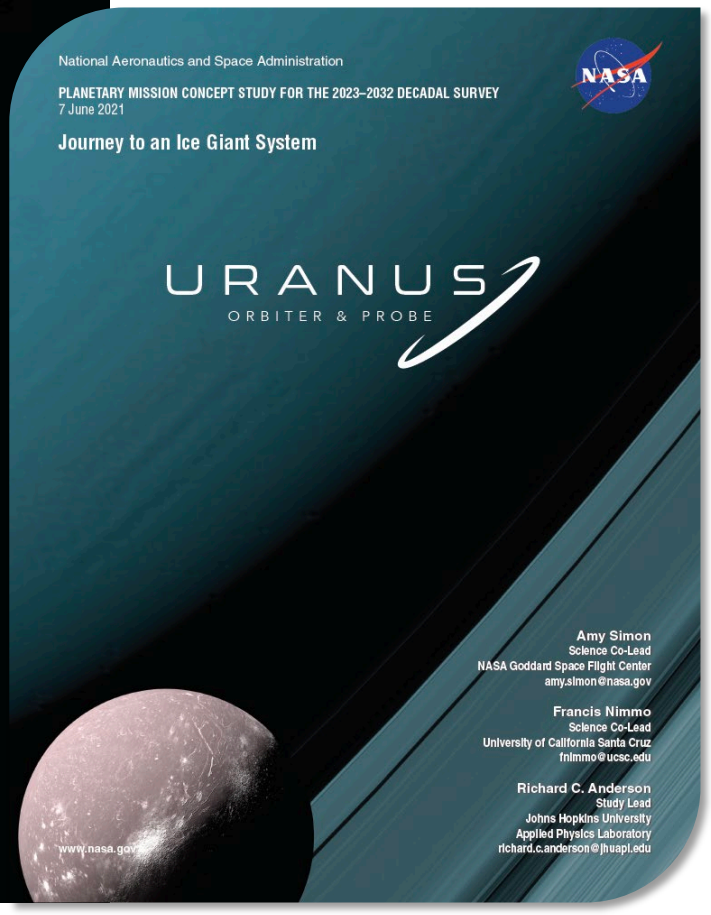
ESA Medium-Class Mission

NASA contribution includes VenSAR (Synthetic Aperture Radar)



Uranus Orbiter and Probe

Uranus Orbiter and Probe recommended by the NASEM Decadal Survey as the next Planetary “Flagship” mission




NASA and Australia

NASA – Australia Cooperation

NASA has close to 30 active agreements with a variety of Australian organizations with a shared interest in Earth science, space science, human space exploration, and education.



Partnering with Australian National University on Low-Cost Optical Terminal



Australia signs Artemis Accords in Oct 2020 (photo Credit ASA)



NASA Astrophysics Sounding Rockets Launched in Northern Territory

Astrobiology field work in the Pilbara (photo credit: Eben Rose)



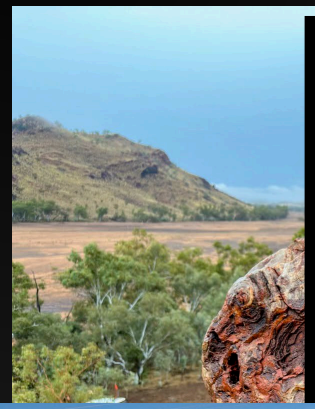
NASA and ASA are collaborating on a lunar rover for launch in 2026 (photo Credit ASA)



2023 Field Visit to the Pilbara

The Pilbara stromatolite formations represent the earliest evidence of life on Earth (~2.72 billion years old) and contributes to astrobiology studies, as a Mars analog site









Canberra Deep Space Communications Complex (CDSCC)

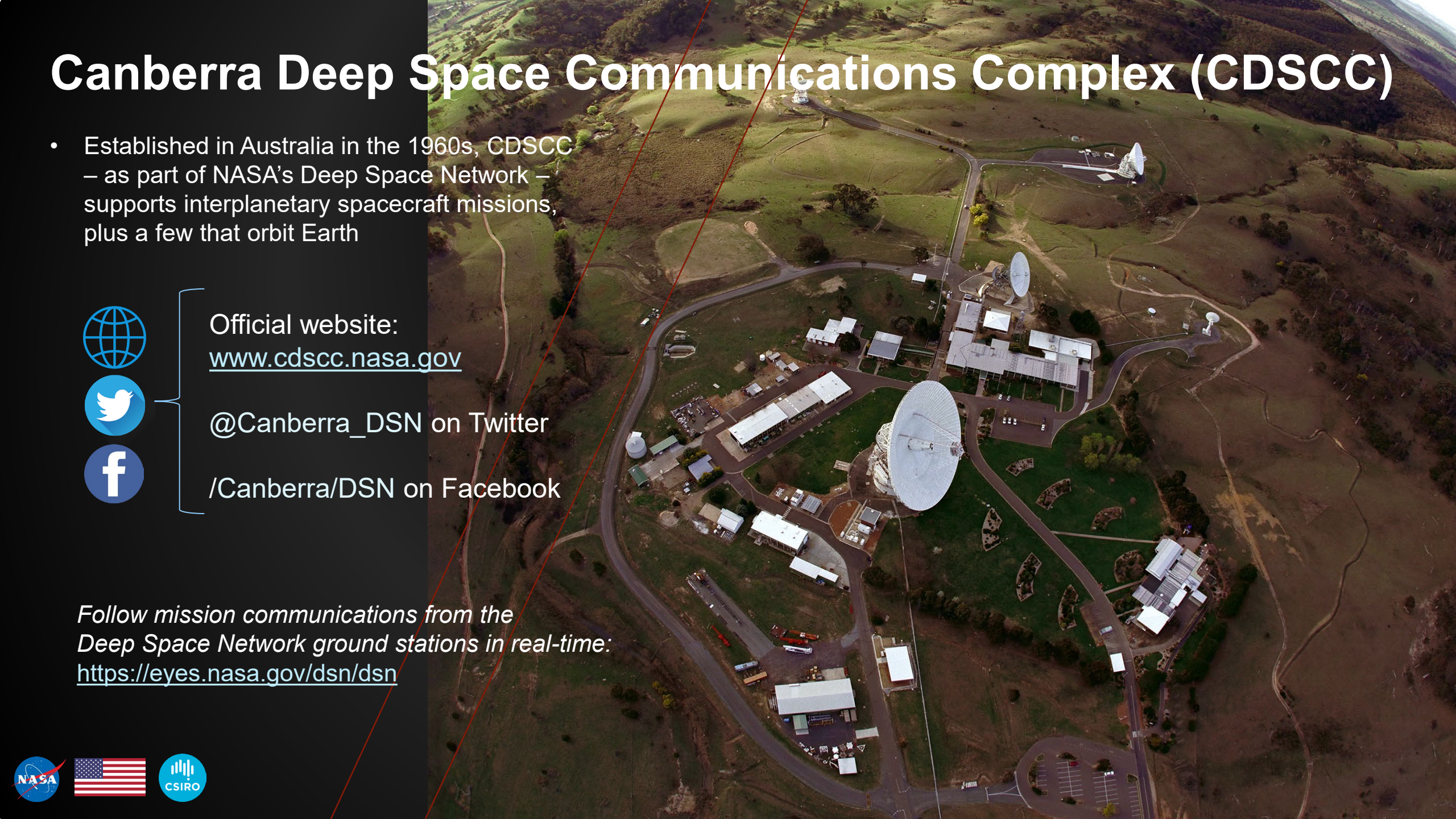
- Established in Australia in the 1960s, CDSCC – as part of NASA's Deep Space Network – supports interplanetary spacecraft missions, plus a few that orbit Earth

Official website:
www.cdscc.nasa.gov

@Canberra_DSN on Twitter

/Canberra/DSN on Facebook

Follow mission communications from the Deep Space Network ground stations in real-time:
https://eyes.nasa.gov/dsn/dsn



NASA, ESA, JAXA, ASA, and CSIRO Collaborating on Mars Technology




EXPLORE
With Us