Planetary Protection at NASA: Overview and Status

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NASA Planetary Protection Officer

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2014 NASA Strategic Goals

<u>Strategic Goal 1:</u> Expand the frontiers of knowledge, capability, and opportunity in space.

Objective 1.1: Expand human presence into the solar system and to the surface of Mars to advance exploration, science, innovation, benefits to humanity, and international collaboration.

Objective 1.2: Conduct research on the International Space Station (ISS) to enable future space exploration, facilitate a commercial space economy, and advance the fundamental biological and physical sciences for the benefit of humanity.

Objective 1.5: Ascertain the content, origin, and evolution of the solar system and the potential for life elsewhere.

NASA Planetary Protection Policy

- The policy and its implementation requirements are embodied in NPD 8020.7G *(NASA Administrator)*
  - Planetary Protection Officer acts on behalf of the Associate Administrator for Science to maintain and enforce the policy
  - NASA obtains recommendations on planetary protection issues (requirements for specific bodies and mission types) from the National Research Council's Space Studies Board
  - Advice on policy implementation to be obtained from the NAC Planetary Protection Subcommittee
- Specific requirements for robotic missions are embodied in NPR 8020.12D *(AA/SMD)*
  - Encompasses all documentation and implementation requirements for forward and back-contamination control
- NASA Policy Instruction 8020.7 "*NASA Policy on Planetary Protection Requirements for Human Extraterrestrial Missions*" released in NODIS as of May 28, 2014

Role of PPS

- Provides expert advice to NASA on planetary protection, as part of the NASA Advisory Council
  - Reviews mission activities and makes recommendations on implementation options
  - Considers and advises on specific points of policy that are below the resolution of international policy set by the Panel on Planetary Protection of the Committee on Space Research
  - Provides guidance regarding programmatic direction and issues of importance/relevance to future missions and implementation of planetary protection requirements
- Serves as a mechanism for interagency coordination within the US Government and internationally
  - Ex Officio membership from a range of US Gov't organizations, as well as other national/regional space agencies

Recent Recommendations

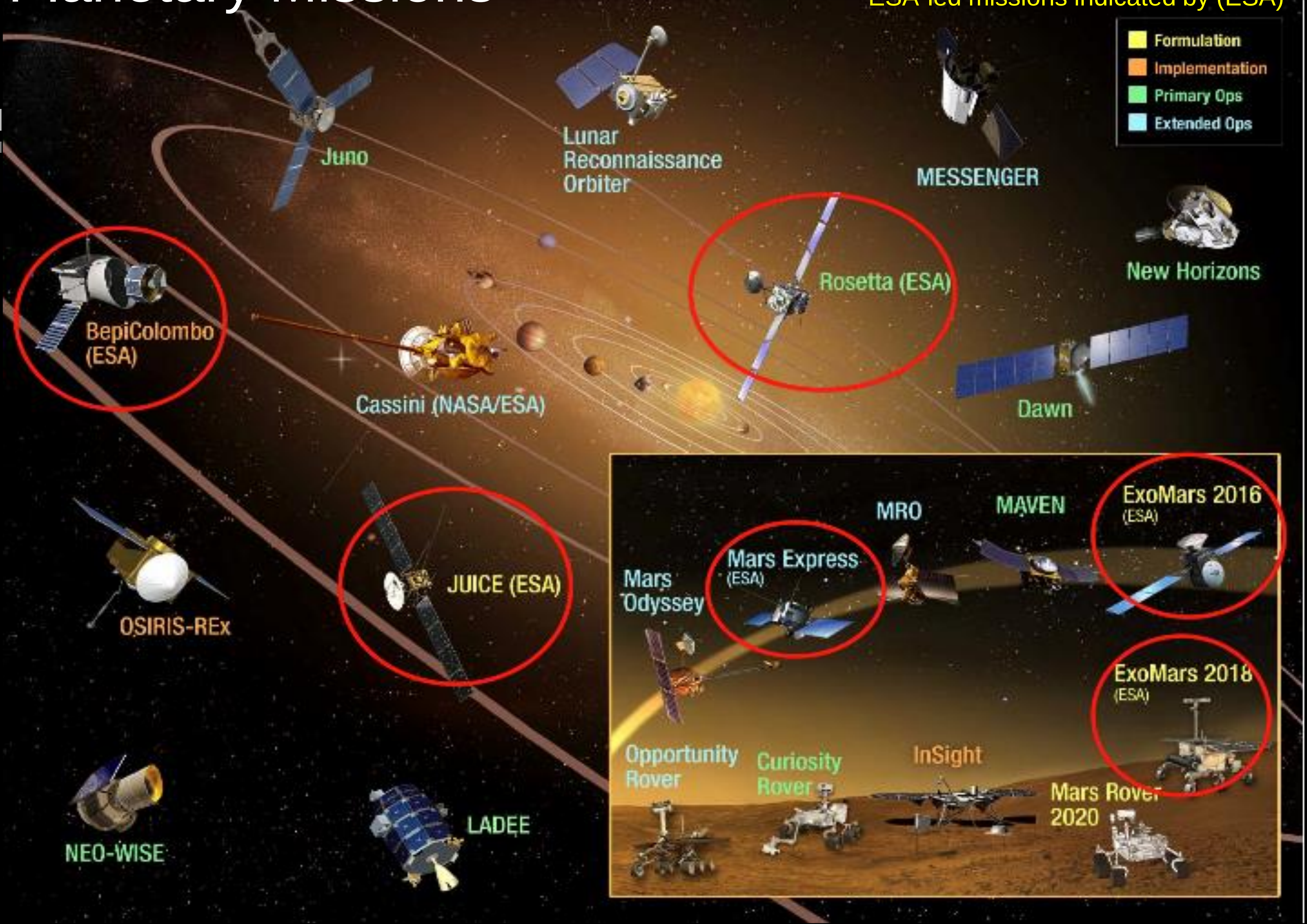
- Nov. 2012 meeting
  - No formal recommendations
  - Observations and information
    - Concern expressed regarding inclusion of planetary protection issues in the Office of Chief Engineer study on lessons learned from MSL responses ongoing
- Apr. 2013 meeting
  - Recommendations
    - Include PPO early in mission planning and design in work
- Nov. 2013 and May 2014 meetings
  - No formal recommendations; concerns from above reiterated
- Nov. 2014 meeting
  - Recommendations
    - Improve MSL Project Office – Planetary Protection Officer Communications in work
    - Ensure Planetary Protection input to NASA assessment of launch and reentry license applications to the DoT/FAA by Non-Governmental Entities in work
  - Observations and information
    - Pleased by improved communications with InSight, M2020, and HEO
    - Concerned that the reporting line of the PPO be consistent with responsibility to assure continued treaty compliance across programs in multiple directorates
    - Concerned that joint meetings with ESA were not held Lindberg at 4/15 PPWG

Ongoing Actions

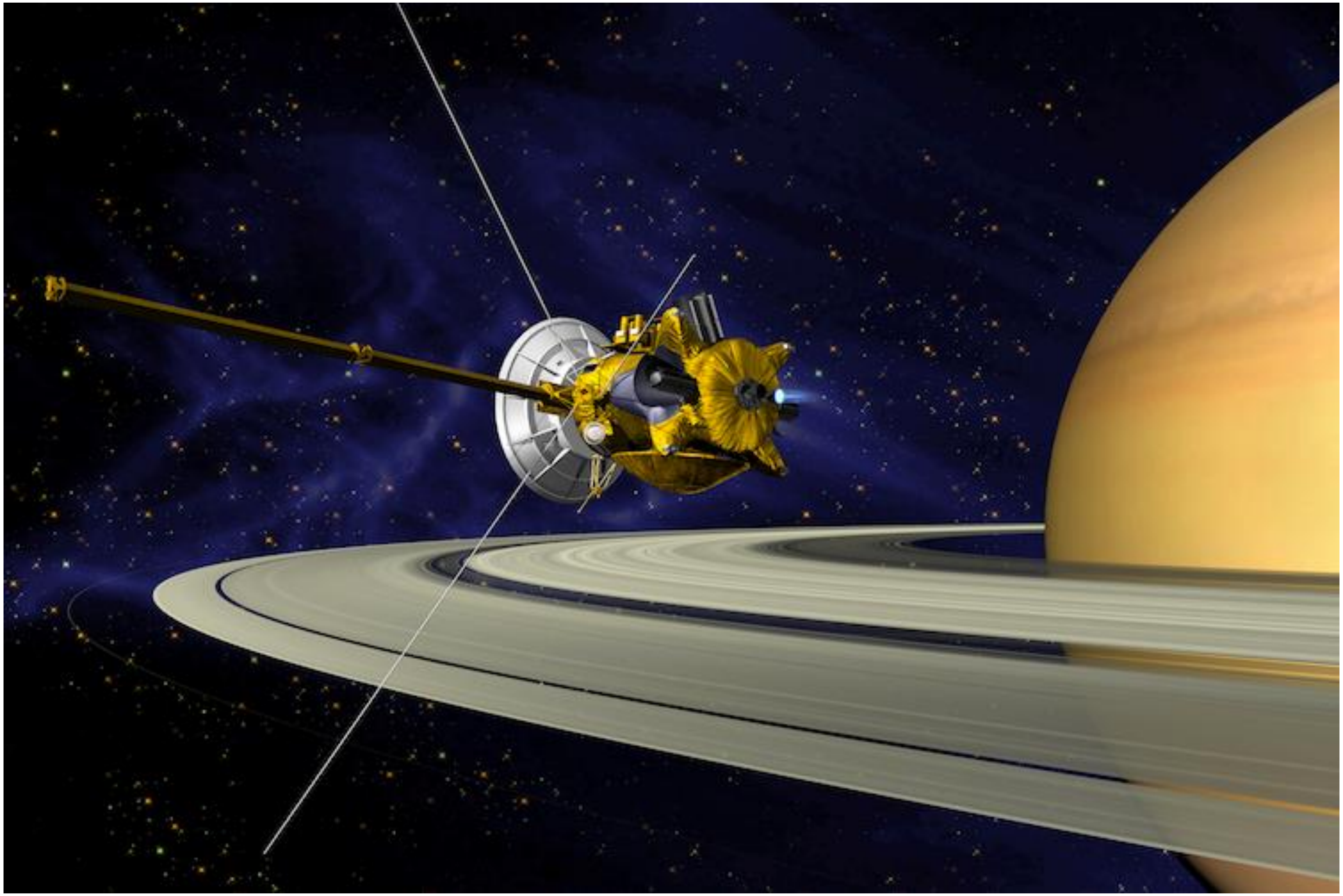
- Responses to prior findings
  - SMD lead on responses to Lessons Learned initiated
    - Ensure appropriate requirements flowdown in discussions with M2020
    - Revise/coordinate planetary protection documentation A-M Novo-Gradac
    - Expand training options A. Spry and A-M Novo-Gradac
    - Continue cross-directorate coordination A-M Novo-Gradac
  - Exploring opportunities for interaction with SMA
- Internal SMD activities
  - Ensure appropriate separation of implementation activities in PSD from regulatory/oversight activities of PPO
  - Develop and support Office of Planetary Protection operating plan
    - Anne-Marie Novo-Gradac assigned to support OPP
    - Include planetary protection in Launch Services Contract
  - Work closely with missions, active and in development B. Pugel
    - MSL, M2020, InSight; MAVEN, MOM, MRO
    - Cassini, Dawn, New Horizons, Juno,
    - Europa Concept, Discovery and New Frontiers AOs
    - missions supporting HEO – e.g. ARM

Planetary Missions

Nearly all NASA missions have multiple-agency contributions;
ESA-led missions indicated by (ESA)



Cassini-Huygens Extended Mission



New Frontiers Program

1st NF mission
New Horizons:

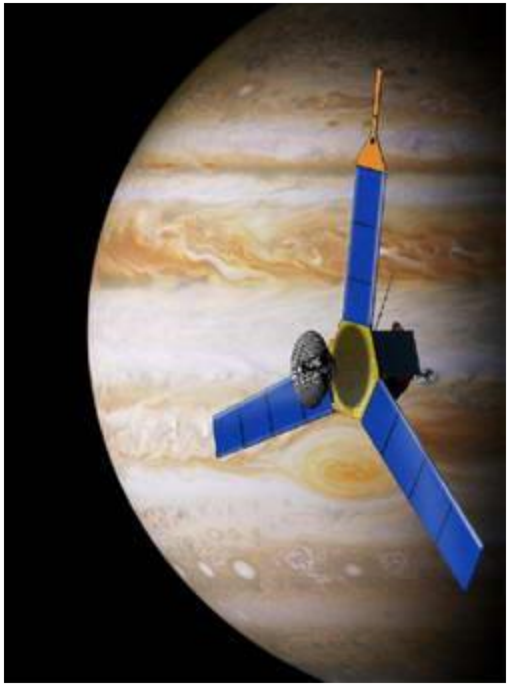
Pluto-Kuiper Belt Mission

Launched January 2006
Arrival July 2015

Category II

2nd NF mission
JUNO:

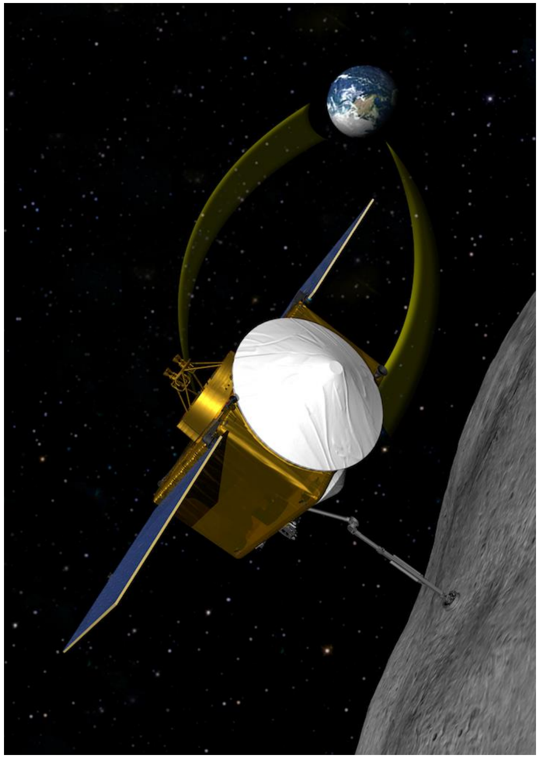
Jupiter Polar Orbiter Mission



August 2011 Launch
Arrival 2017

Category III

3rd NF mission
OSIRIS-REx
Asteroid Sample Return

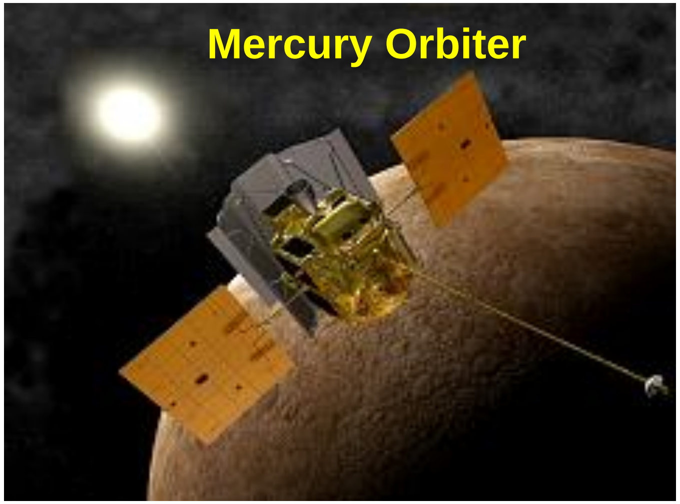


September 2016 Launch
Arrival 2019

Category V Unrestricted

Discovery: Operating Planetary Missions

MESSEnGER:



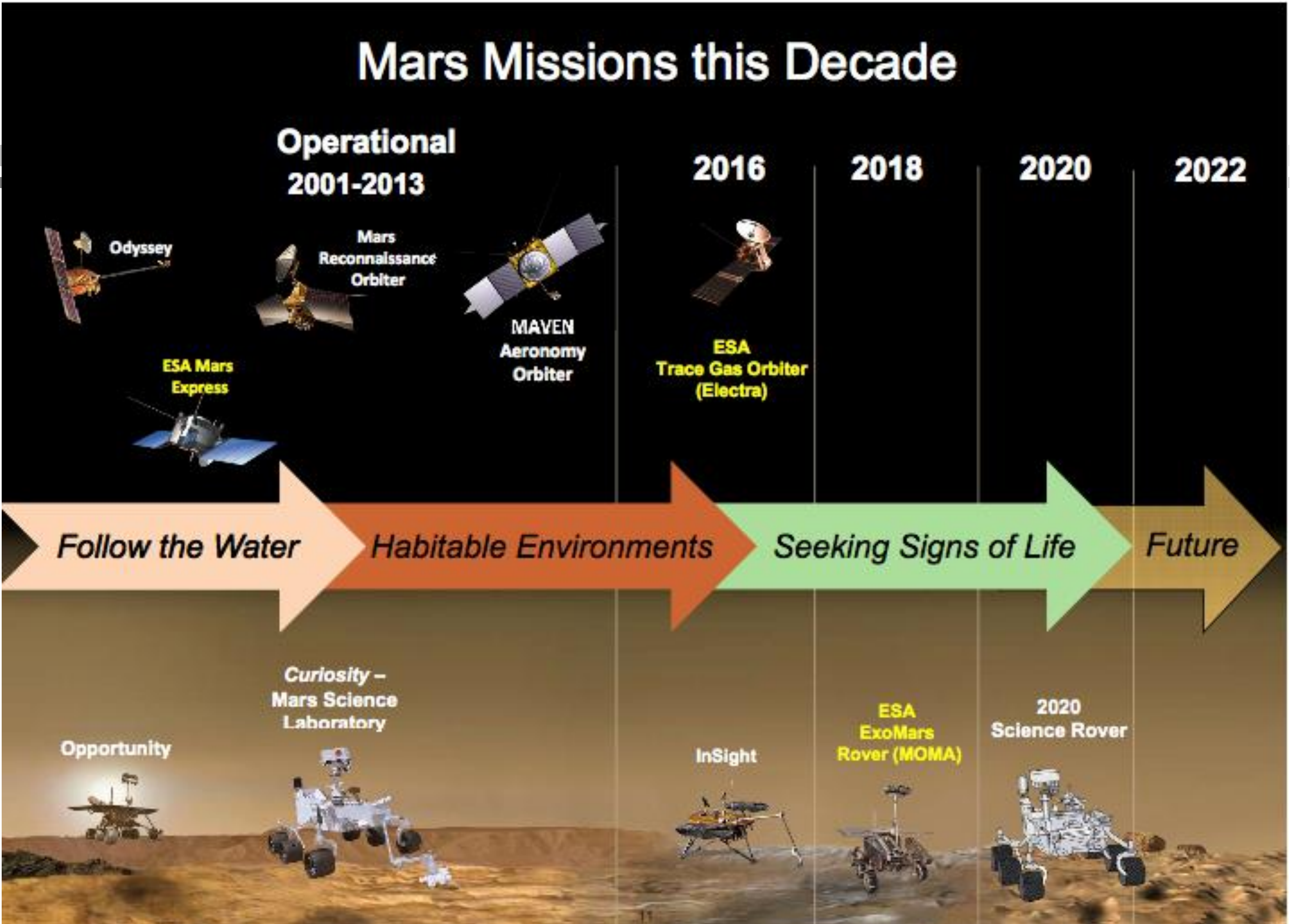
Category II
In orbit at
Mercury

GRAIL:

Category II
Impact on lunar surface
Dec. 17, 2012

Dawn:

Category II
Dawn will not impact
Ceres due to orbital
mechanics constraints


Mars Missions this Decade
Operational
2001-2013
2016
2018
2020
2022
Odyssey
Mars
Reconnaissance
Orbiter
MAVEN
Aeronomy
Orbiter
ESA
Trace Gas Orbiter
(Electra)
ESA Mars
Express
Follow the Water
Habitable Environments
Seeking Signs of Life
Future
Curiosity –
Mars Science
Laboratory
Opportunity
InSight
ESA
ExoMars
Rover (MOMA)
2020
Science Rover

2012 Discovery Selection

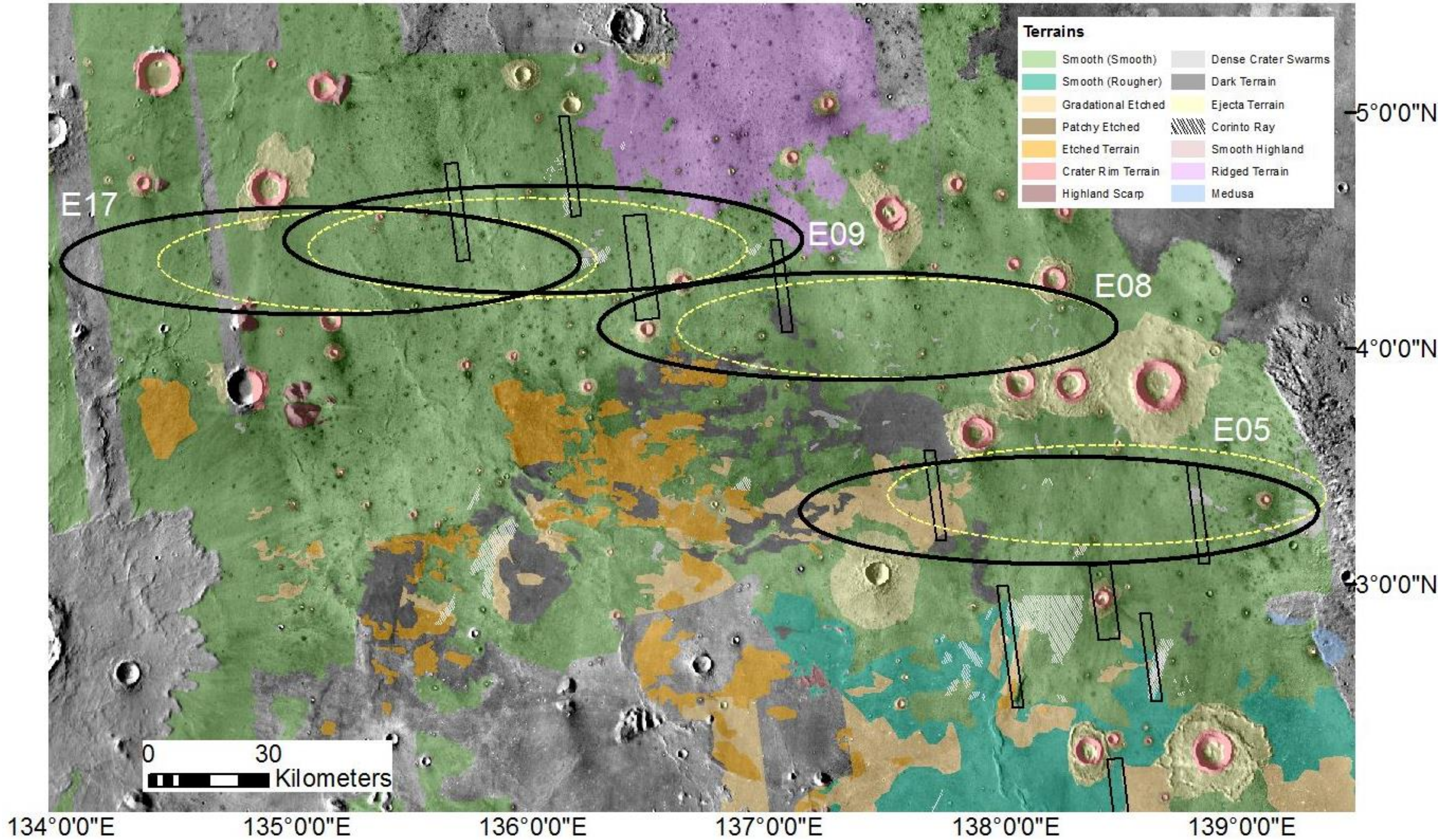
Category IVa

Launch March 2016

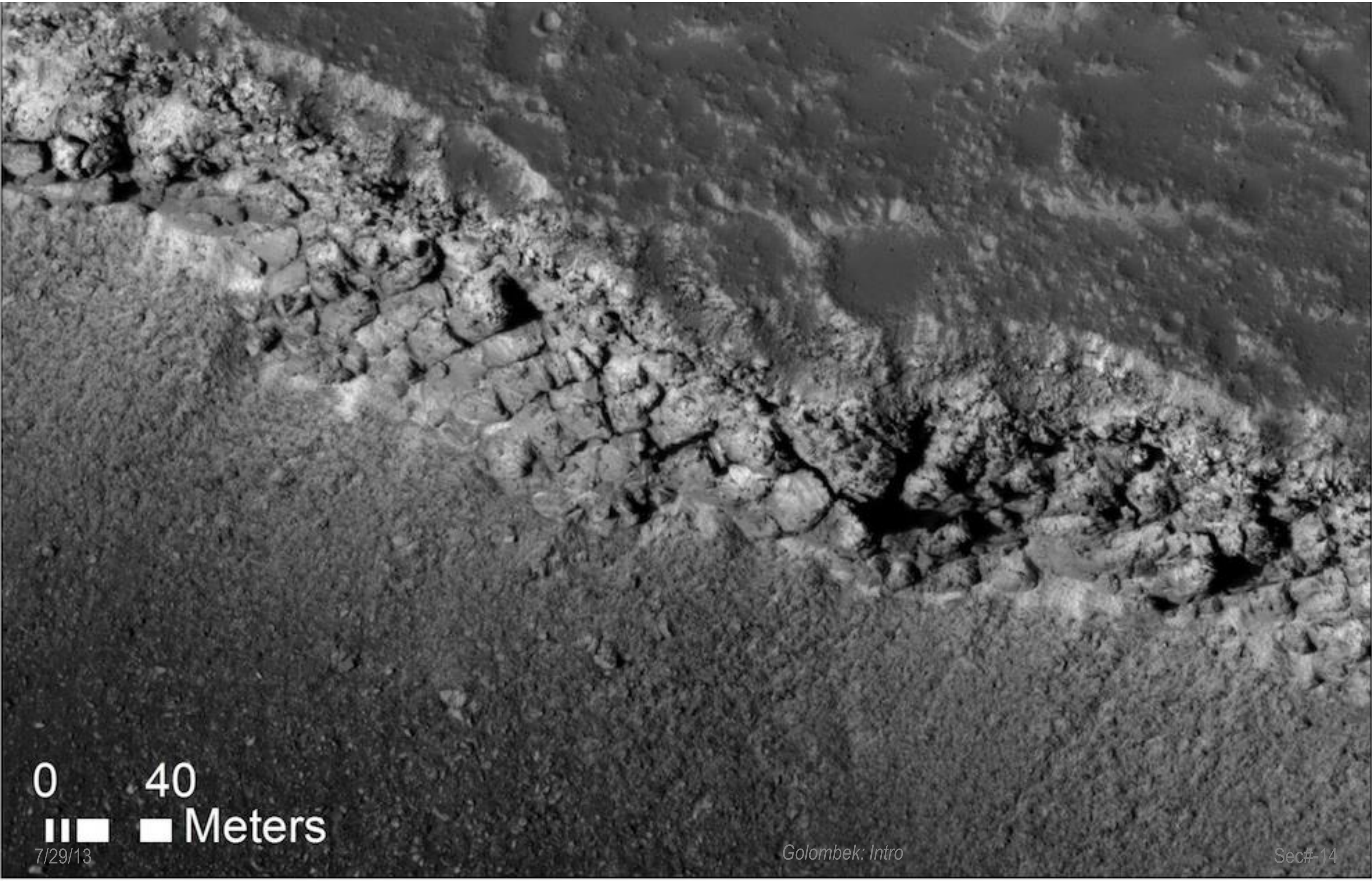
- Demonstrate, by observation and analysis, that mole will not access Mars special regions

Discovery ' 14 Released

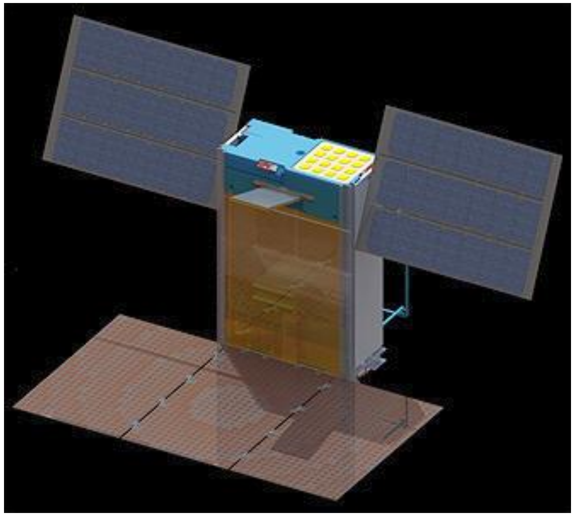
InSight Landing Selection: Elysium Planitia

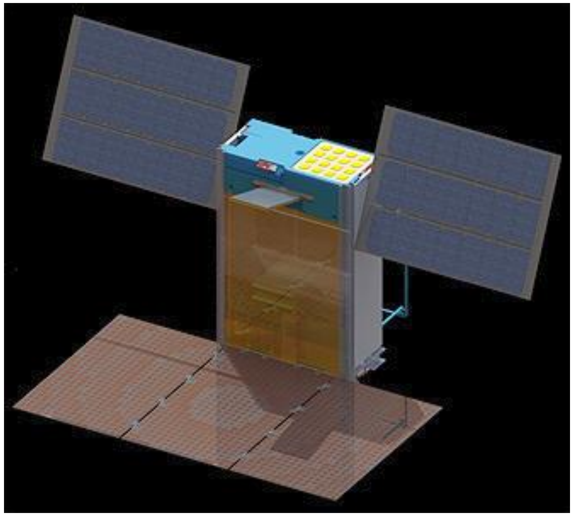


Cross Section of Regolith



MarCo CubeSat Secondary Payload



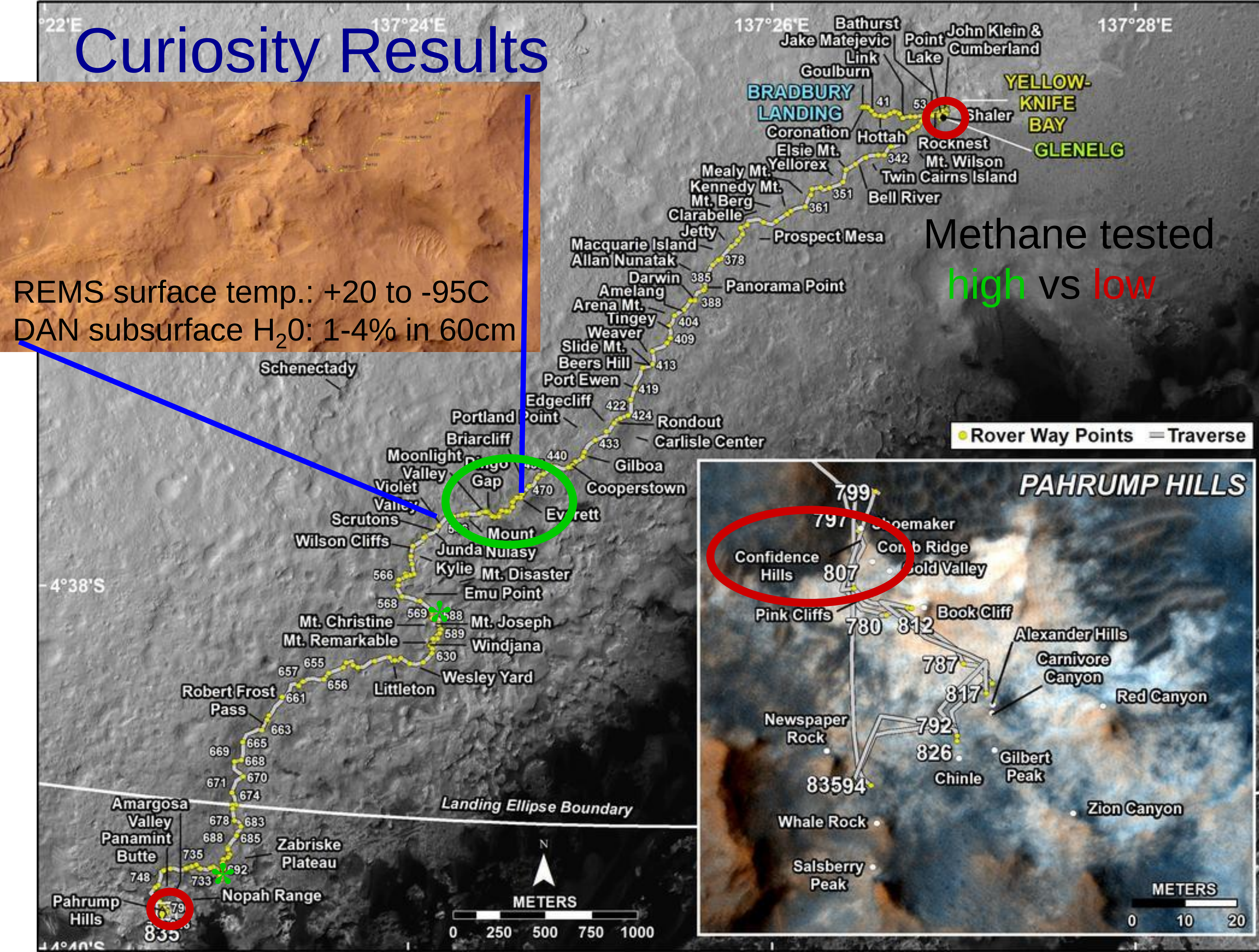


- Two Cubesats to follow InSight to Mars and provide communications during EDL.
- Nominal mission is a flyby: Cubesats continue in heliocentric orbit.
- Cubesat launcher is mounted at the base of the upper stage: requires Mars impact avoidance at $<1 \times 10^{-4}$, or Burn-up and Break-up analysis.
- Good communication between all payloads and the launch vehicle providers are essential, to ensure that planetary protection requirements on the primary payload are not violated.

Curiosity Results

REMS surface temp.: +20 to -95C
DAN subsurface H_2O: 1-4% in 60cm

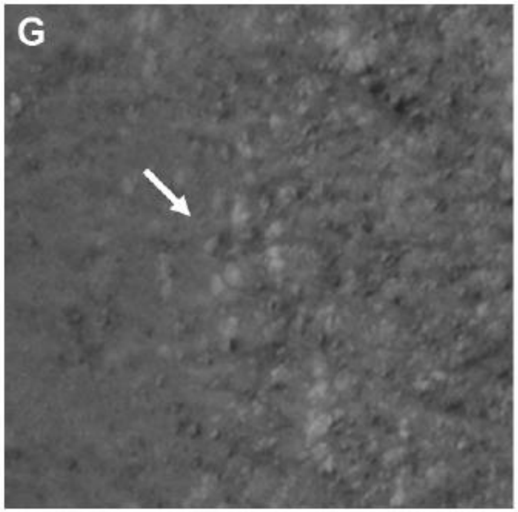
Methane tested
high vs low

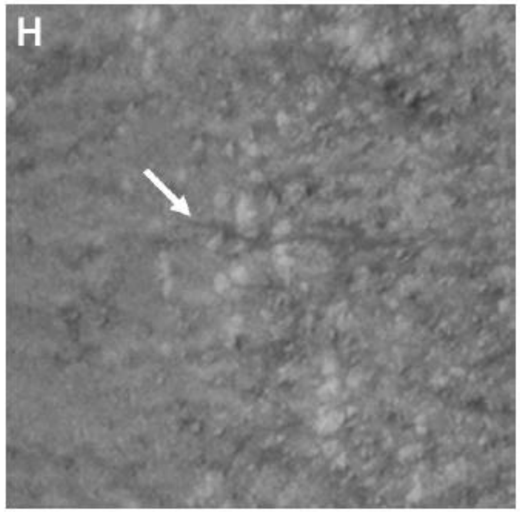


Curiosity
New Traverse

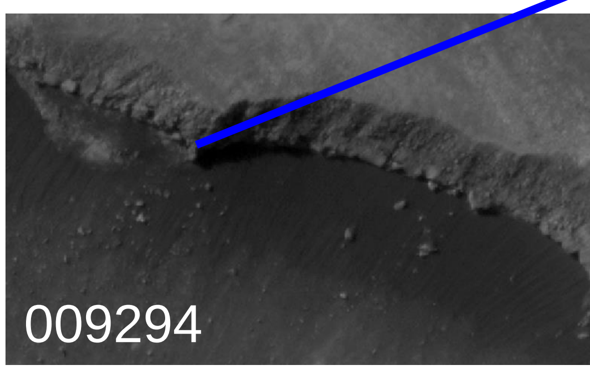
ection

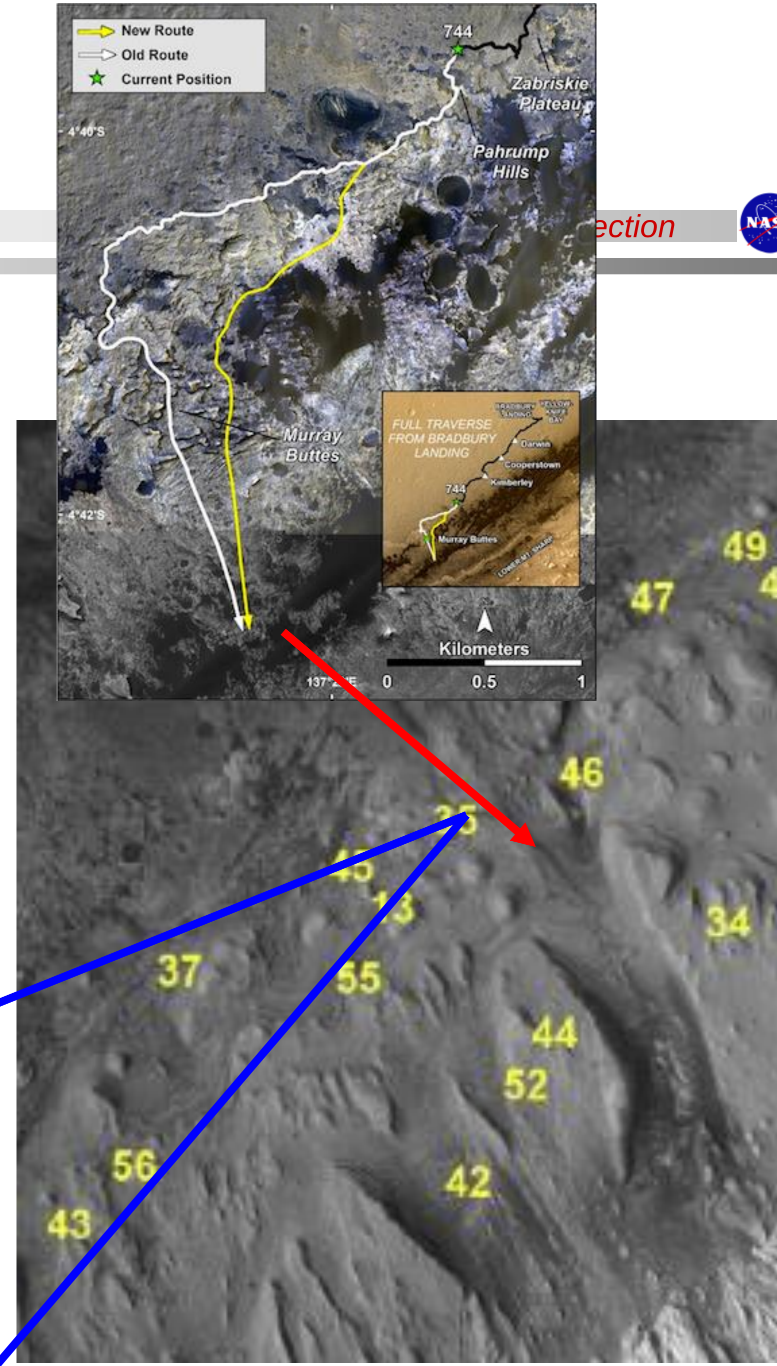
Many Dark Streaks, Possible RSLs....





CM Dundas & AS McEwen, (2015) Icarus 213–218

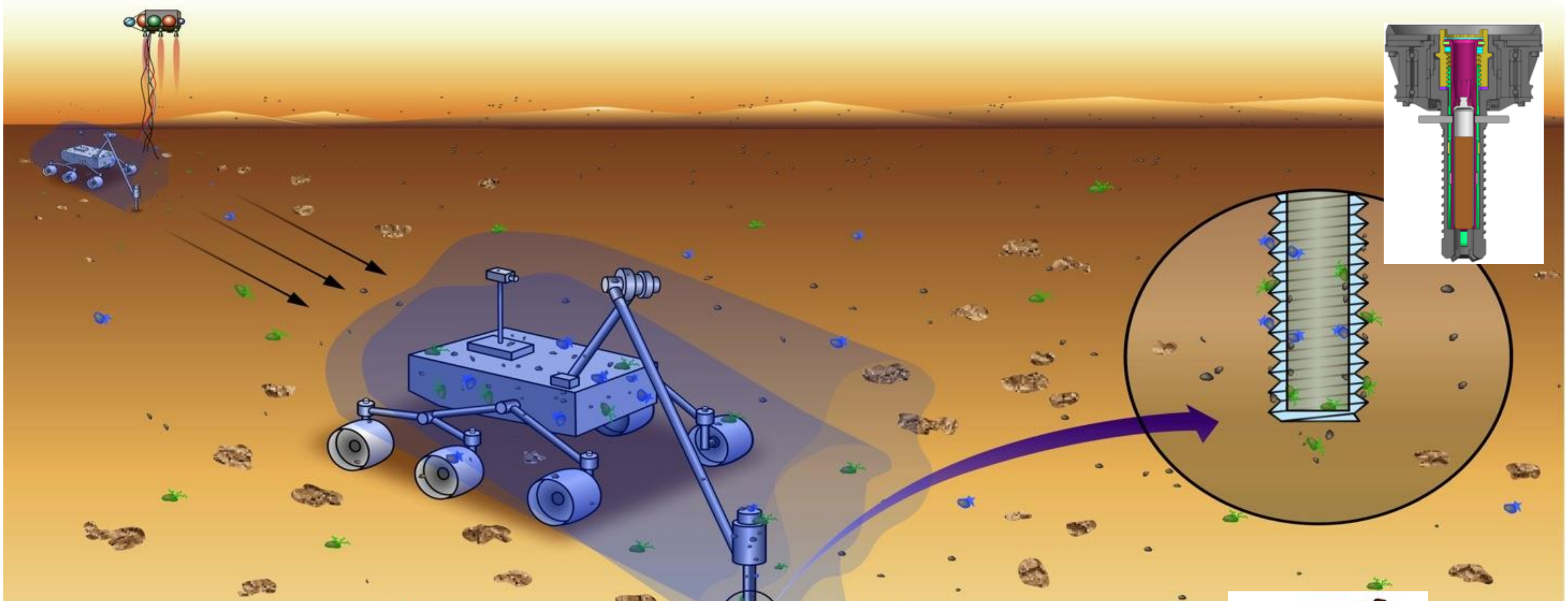




M2020: Planetary Protection

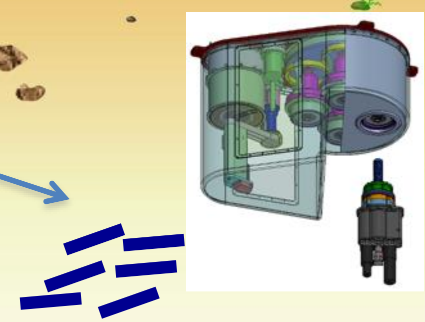
- Individual mission category, not part of a campaign: Partial categorization letter provided to project, date 7 May 2015
  - Categorization required before Key Decision Point-B (KDP-B)
- Payload includes a subsurface sampling system and caching hardware to collect and enclose samples for possible future return to Earth
- Payload has the capability to perform near-surface measurements of organic 'biosignature' compounds in situ, with at least ppm sensitivity
- M2020 mission shall be required to comply with requirements for Planetary Protection Category IVb implemented at subsystem level, as a mission to Mars that will not access Special Regions, but that will conduct "scientific investigations of possible extraterrestrial life forms, precursors, and remnants"
- Clarified sections of NPR 8020.12:
  - 5.3.2.2.b implemented at subsystem level, requirements for in situ instruments investigating 'precursors or remnants' of life
  - 5.3.2.3.c and 5.3.2.5.c, requirements for avoiding access to or creation of special regions
  - 5.3.3.2 and 5.3.2.7, requirements for Category V Restricted Earth Return

M2020: Evolving Concepts for Sampling



There are at least three pathways by which contaminants can be transported into samples:

- Direct contact – microbial and molecular contaminants are transferred from the hardware surfaces to samples by direct contact.
- Particle transport – Microbes and molecular contaminant-containing particles are dislodged from spacecraft hardware surfaces by wind or by mechanical forces and are then carried by wind to the sampling ground or into the sample tube.
- VOC transport – outgassed volatile organic compounds from nonmetallic parts will diffuse or be carried by wind to condense on the sampling ground, sample contacting hardware, and samples.



Deposit container or individual sample tubes

SSB Meeting of Experts Process (PPS participation)

HQ/Mars Exploration Program-convened
Organic Contamination Panel

Start: March 2014
Draft Report: May 16, 2014

PPS Review of MEP–convened Organic Contam Panel Report

Finalized late 2014, minority opinion from former member received in early 2015

NRC-convened Meetings of Experts

May 2014 and May 2015, additional meetings in planning

Provide feedback to NASA: support inputs to Earth Safety Analysis

Pending final report from MEP Science Org. Contam Science Study Lead

Ongoing PPS Review

Provide to Mars 2020

Goals:
- Single PP/Science cleanliness requirement
- Recorded in L1 Requirements

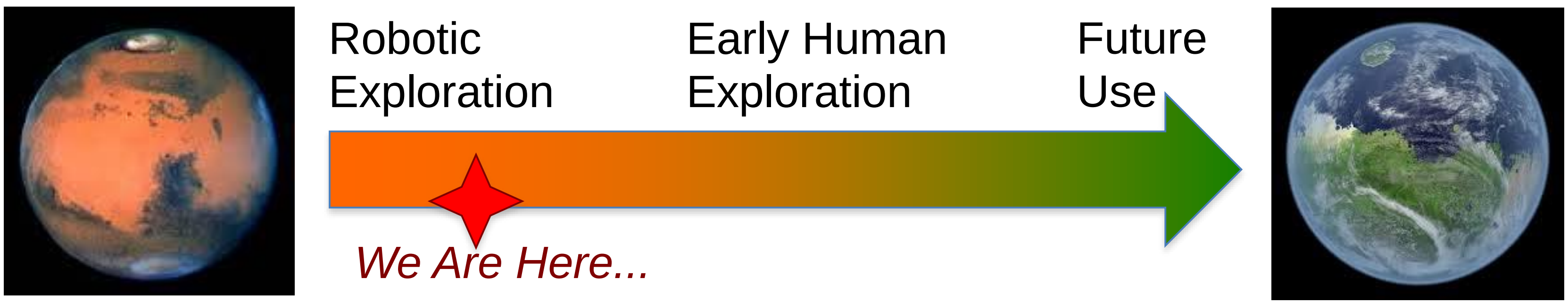
Planetary Protection for Humans on Mars

Outer Space Treaty:

Protect the Earth, Avoid Harmful Contamination

International (COSPAR) Policy:

Adding humans. policy has the same intent but different implementation



Phased Approach: Be careful early; tailor later constraints using knowledge gained

•Humans have many interests at Mars; understanding potential hazards supports all of them

•Searching for Mars life becomes more difficult, the more Earth contamination is introduced

•Future colonization could be challenged, if unwanted Earth invasive species are introduced

- Blocking aquifers
- Consuming resources
- Interfering with planned introductions

NASA Policy Instruction in place: Human mission requirements under development by HEO and SMD

WORKSHOP

Planetary Protection Knowledge Gaps for

Human Extraterrestrial Missions

Website:
www.nasa.gov/ames/ppw2015
workshop/

Registration:
www.hou.usra.edu/meetings/p
pw2015/

MARCH 24–26, 2015

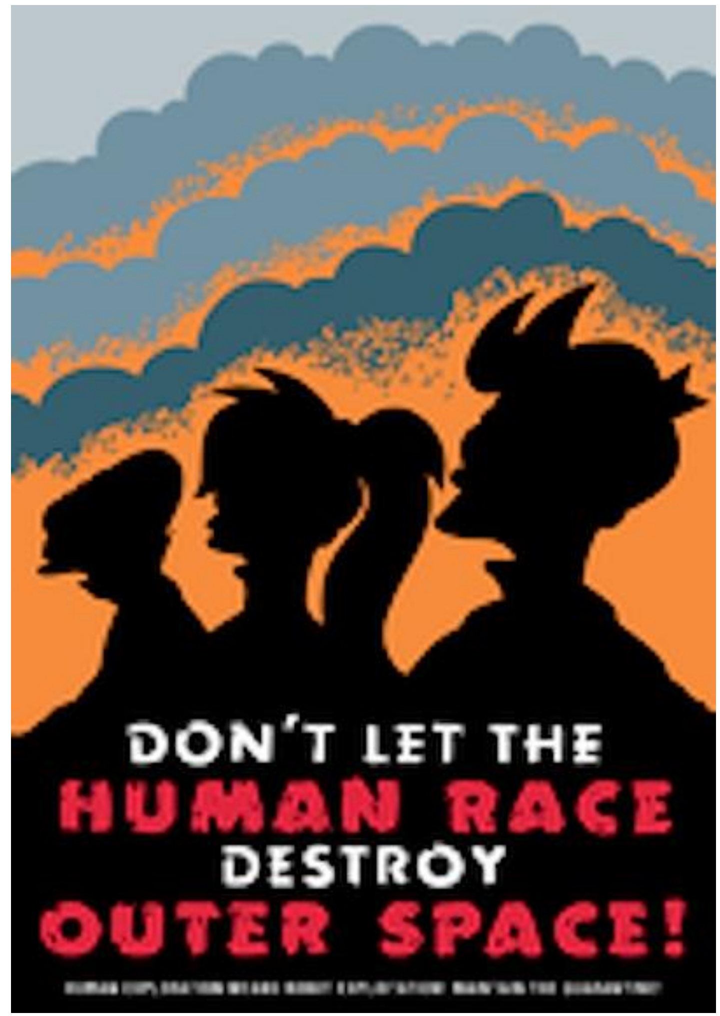
NASA AMES RESEARCH CENTER, CA

Planetary Protection Support

- Increased staffing
  - B. Pugel and T. Errigo, detailee/support from GSFC
  - A.-M. Novo-Gradac, assigned from SMD
- Frequent interactions with SMD Deputy AA
  - regular constructive meetings with MEP and M2020 project
  - clarification of roles/responsibilities leading to improved communication and interfaces
- Strengthening interfaces with HEO and STMD
  - identifying Center points of contact beyond HQ
- Budget increasing to accommodate expanded responsibilities
  - improved programmatic support
  - PPR research program selected 6 proposals from ROSES14

Questions?


KEEP YOUR
HELP FIGHT NECK ROT
FUTURAMA
R.U.R.
REHABILITATE UNSANITARY ROBOTS
ROBOT CLEAN


DON'T LET THE
HUMAN RACE
DESTROY
OUTER SPACE!