INTREPID

TRAVERSING FOUR BILLION YEARS OF LUNAR HISTORY

Intrepid's investigation across six diverse geologic regions would reveal undiscovered aspects of lunar evolution, paving the way for the next decade of planetary exploration.

SCIENCE THEMES AND OBJECTIVES:

THEME 1 Evolution of the lunar interior and nature of the Procellarum KREEP Terrane

1.1 Determine the cause of extended volcanism in the Procellarum region

1.2 Determine the cause of the lunar crustal asymmetry

1.3 Test hypotheses for the origin of non-basaltic volcanism

1.4 Determine composition of deep mantle from pyroclastic deposits

1.5 Determine decline of core dynamo and magnetic field over time

THEME 2 Diversity of styles of magmatism

2.1 Characterize flood basalt emplacement, rilles, flows, vents

2.2 Determine origin(s) and composition(s) of cones, domes and shields

2.3 Characterize pyroclastic volcanism processes: composition and physical state

2.4 Determine the relationship between intrusive (plutonic) and effusive (volcanic) materials

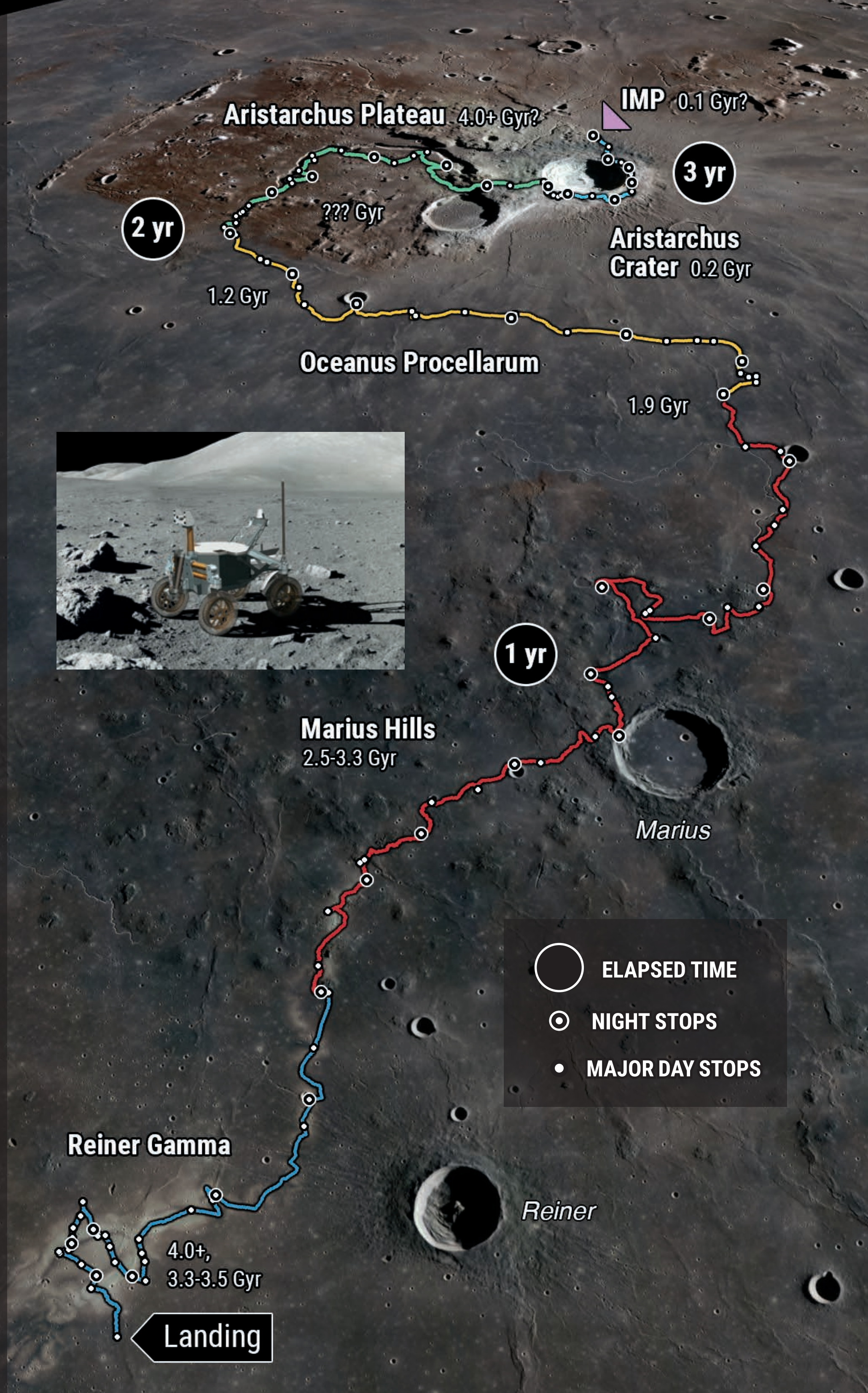
THEME 3 Post-emplacement modification of magmatic materials

3.1 Test hypotheses of impact crater formation, ballistic sedimentation, ray formation

3.2 Determine target material influence on impact crater formation

3.3 Determine the causes of magnetic anomalies, swirls and space weathering

Pre-Decisional Information – For Planning and Discussion Purposes Only



The last fifty years of planetary exploration have shown that knowledge of planetary scale differentiation, global asymmetries, and thermal evolution are essential to understanding how planets change over time and how they develop their unique characteristics. *Intrepid* would explore the giant geochemical and volcanic anomaly known as the Procellarum KREEP Terrane (PKT) and interrogate four billion years of lunar history by traversing through a unique juxtaposition of six key geologic regions not sampled by previous missions. *Intrepid*'s results, combined with global orbital observations and what we know from samples collected outside the PKT, would provide for the first time a holistic picture of large scale mantle processes and the thermal evolution of a silicate body other than Earth.

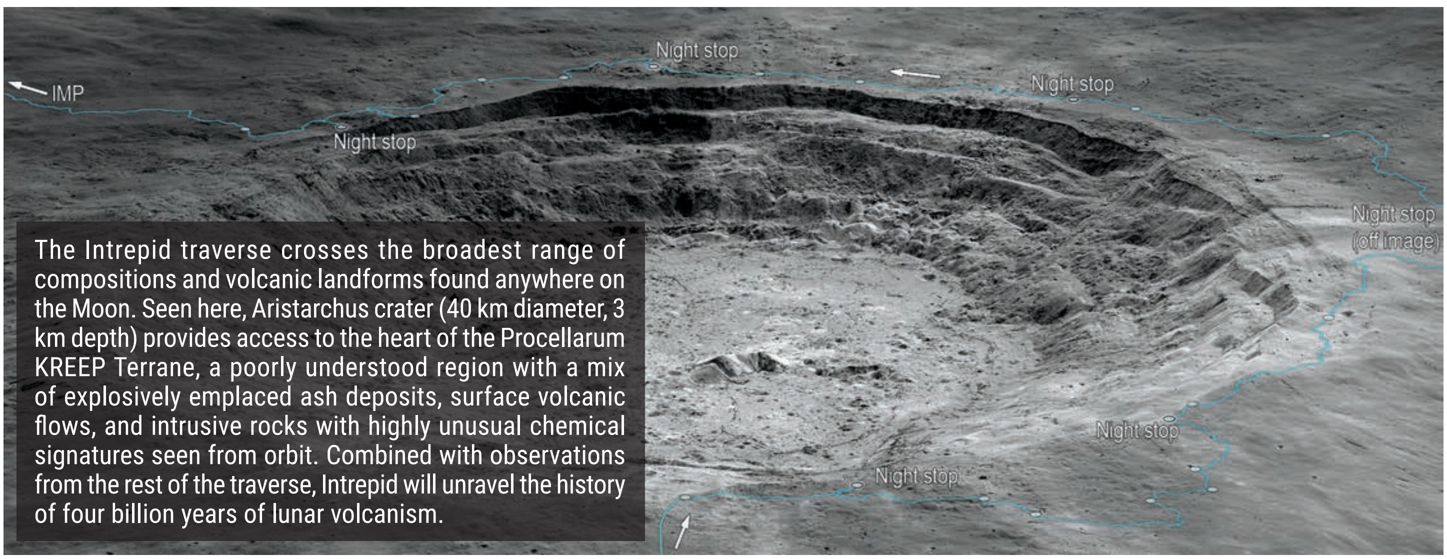
MISSION CONCEPT

The Intrepid mission concept relies on high-TRL hardware, advanced autonomy, detailed traverse pre-planning, night operations, and a disciplined concept of operations that enable the investigation of 133 major and 981 minor scientific sites along an ~1800 km traverse over 4 Earth years (3-years nominal, plus 1-year margin).

- *Intrepid* would touch down just south of the **Reiner Gamma** magnetic anomaly and traverse across and along the "swirl" to definitively test hypotheses for the origin of the anomaly and swirl (intrusive rock >4 Gyr, basalts 3.3 to 3.5 Gyr in age).
- *Intrepid* would then traverse the **Marius Hills** volcanic complex (2.5 Gyr) to investigate cones, flows, vents, and putative volcanic ash deposits.
- Next, *Intrepid* would rove northward across **Oceanus Procellarum**, some of the youngest (1.2 Gyr to 1.9 Gyr) lunar mare deposits, making a suite of compositional observations of the mare and rays from Aristarchus crater to test hypotheses concerning the existence of KREEP-rich basalts and ray mixing systematics.
- Once on the **Aristarchus plateau**, *Intrepid* would characterize the largest pyroclastic deposit on the Moon (perhaps 2.5 Gyr), unlocking the deep mantle and prospecting for potential H deposits.
- *Intrepid* would then traverse the rim of the impressive **Aristarchus crater** (~0.2 Gyr), assessing ejected crustal material within the PKT (3.5 Gyr to >4.0 Gyr).
- Finally, *Intrepid* would investigate a newly discovered type of volcanic landform, **Irregular Mare Patches** (IMP), which are proposed to represent the youngest (<100 Myr) volcanism on the Moon.

IMPLEMENTATION HIGHLIGHTS

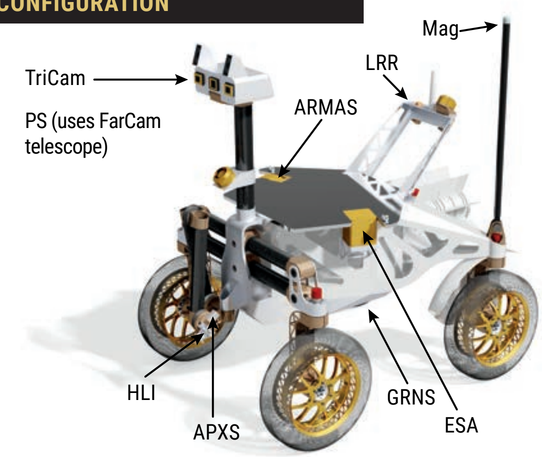
- Rover mass 371 kg (MEV), 2.5 m by 2.0 m footprint
- Power supplied by Next-Gen RTG (274 W EOM) for day/night rover activities
- Four-wheeled design with all-wheel drive and steering for efficient mobility
- Large (80-cm diameter) compliant wheels for improved mobility and longevity
- Robotic arm (5 degree-of-freedom) for autonomous instrument placement
- Mast (2 degree-of-freedom) for science instrument pointing and navigation
- Omni antenna provides Earth communication while in motion; two high-gain fixed antennas provide high-bandwidth downlink when stopped
- Autonomous driving leverages Mars rover capabilities and state-of-the-art terrestrial technology
- Autonomous instrument placement leverages decades of technology development and demonstrations on terrestrial prototypes
- Total cost within New Frontiers budget



The Intrepid traverse crosses the broadest range of compositions and volcanic landforms found anywhere on the Moon. Seen here, Aristarchus crater (40 km diameter, 3 km depth) provides access to the heart of the Procellarum KREEP Terrane, a poorly understood region with a mix of explosively emplaced ash deposits, surface volcanic flows, and intrusive rocks with highly unusual chemical signatures seen from orbit. Combined with observations from the rest of the traverse, Intrepid will unravel the history of four billion years of lunar volcanism.

INSTRUMENT	DERIVED SCIENCE PRODUCT
ARMAS	Galactic cosmic ray flux
Gamma Ray Neutron Spectrometer (GRNS)	Elemental abundance
Alpha Particle X-ray Spectrometer (APXS)	Elemental abundance
Magnetometer (Mag)	Magnetic field strength, depth, orientation, polarity
Electrostatic Analyzer (ESA)	Solar wind flux to surface
TriCam: Stereo RGB Imager, BW FarCam	Landform morphology, albedo, visible color
Point Spectrometer (PS) uses FarCam telescope	Mineral abundance from spectral reflectance
Hand Lens Imager (HLI)	Micro-texture, color, rover inspection, Earth imaging
Inertial Measurement Unit (IMU)	Subsurface density
Laser Retroreflector (LRR)	Location of rover

CONFIGURATION



Mark Robinson, PI
robinson@ser.asu.edu

ASU School of Earth and Space Exploration
Arizona State University
JPL Jet Propulsion Laboratory
California Institute of Technology

Pre-Decisional Information – For Planning and Discussion Purposes Only

Carnegie Mellon University, First Mode, Honeybee Robotics, Johns Hopkins University, Johns Hopkins University Applied Physics Laboratory, Johnson Space Center, Lunar and Planetary Institute, Malin Space Science Systems, Stanford University, University of New Hampshire, Washington University in St. Louis