Jet Propulsion Laboratory
California Institute of Technology

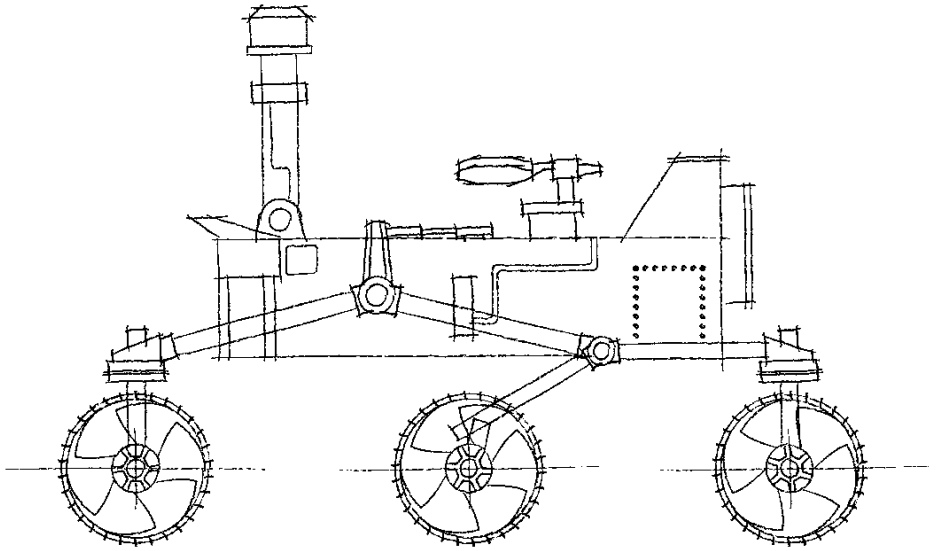
Mars 2020 Mission

Ken Farley

Project Scientist (Caltech)

Fourth Landing Site Workshop

October 16-18, 2018



Mars 2020 Project

Mars 2020 Mission Objectives

A. Geologic Context and History Characterize the processes that formed and modified the geologic record within a field exploration area on Mars selected for evidence of an astrobiologically-relevant ancient environment and geologic diversity

B. In Situ Astrobiology Perform the following astrobiologically relevant investigations on the geologic materials at the landing site:

1. Determine the habitability of an ancient environment.
2. For ancient environments interpreted to have been habitable, search for materials with high biosignature preservation potential.
3. Search for potential evidence of past life using the observations regarding habitability and preservation as a guide.

C. Prepare a Sample Cache Assemble rigorously documented and returnable cached samples for possible future return to Earth.

1. Obtain samples that are scientifically selected, for which the field context is documented, that contain the most promising samples identified in Objective B and that represent the geologic diversity of the field site.
2. Ensure compliance with future needs in the areas of planetary protection and engineering so that the cached samples could be returned in the future if NASA chooses to do so.

D. Enable the Future: Human Exploration

Midway

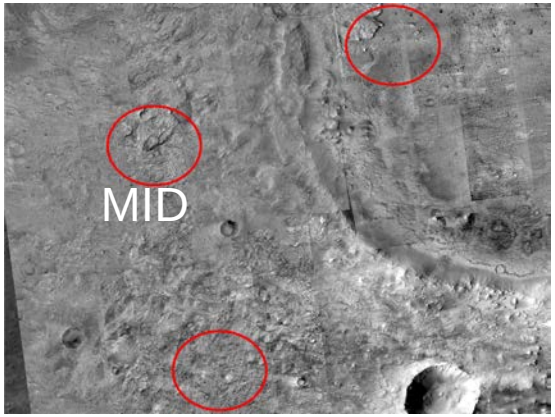
At the end of LSW 3, three potential Mars 2020 landing sites were advanced:

Columbia Hills, Northeast Syrtis, and Jezero.

In responding to requests to the Mars 2020 Project to optimize the location of the NES landing ellipse to meet various science objectives, it was recognized that two sites in Northeast Syrtis terrain were viable from both landing safety and science perspectives:

1) the original NES ellipse

2) An ellipse located ~15 km further north, located mid-way between NES and JEZ.



*Accordingly, the Northeast Syrtis landing site was bifurcated into distinct ellipses: the original ellipse, still called **Northeast Syrtis**, and the new ellipse, called **Midway**. So this workshop will consider 4 candidate landing ellipses.*

Planetary Protection

The Office of Planetary Protection held a review on 10-Sep-2018 to assess the four Mars 2020 candidate landing sites.

Bottom Line of Final Report:

From a planetary protection perspective … all potential landing sites are considered equivalent, leaving science considerations to be the ones to determine the preferred landing site for the mission.

Mission Performance Models

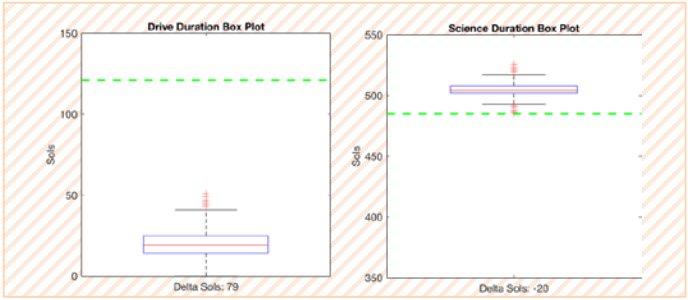
Jet Propulsion Laboratory
California Institute of Technology

Mars 2020 Project

Overall Mission Performance

BRS
80th percentile

Partial Model Results



deltaSols (80th percentile) = # unconstrained sols from BRS mission
adjusted Ops Eff % (80th percentile) = Ops Efficiency needed for 1.25 MY mission

JEZ Example

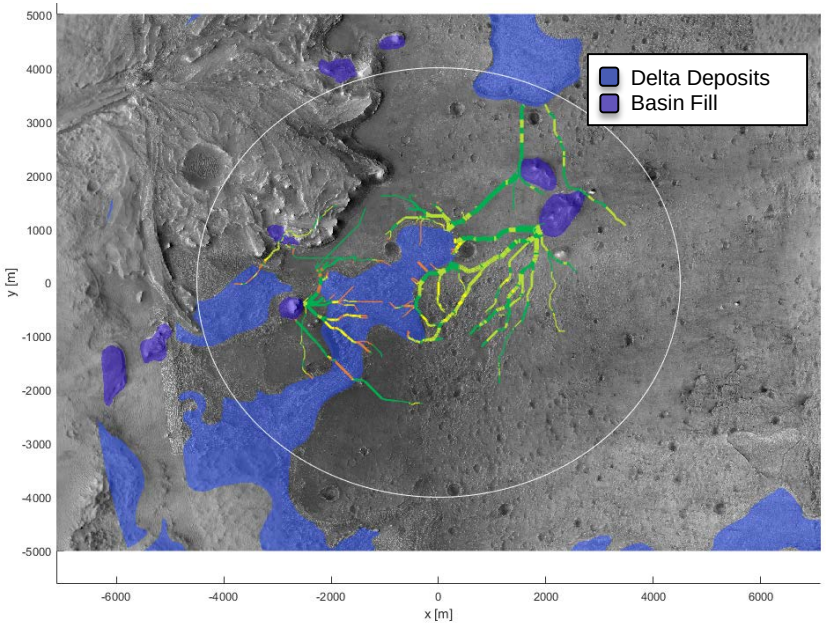
Science Scenario Details

2 ROIs
- Delta Deposits
  - **11 samples**
  - 3 campaigns with 3 units each
- Basin Fill
  - **2 samples**
  - 1 Campaign with 2 units

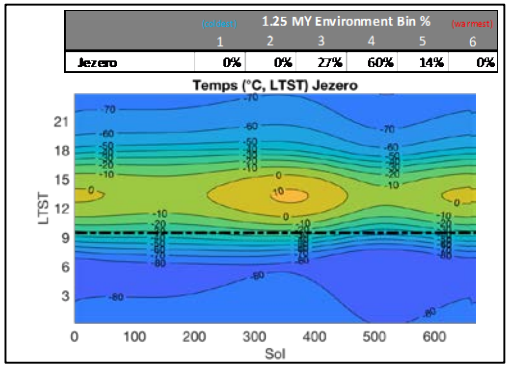
3 Waypoints
- Volcanic Floor (throughout the ellipse)
  - **2 rock samples** separated by 500 m
  - (First sample shortly after landing, second sample after first ROI)
- Regolith (throughout the ellipse)
  - **1 regolith sample** wherever we find sand

+ 4 Witness Tubes

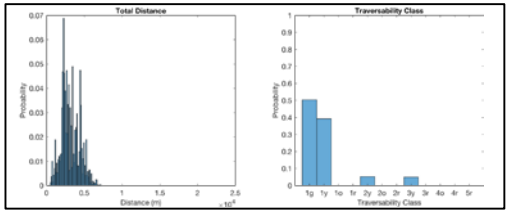
Drive routes to ROI locations



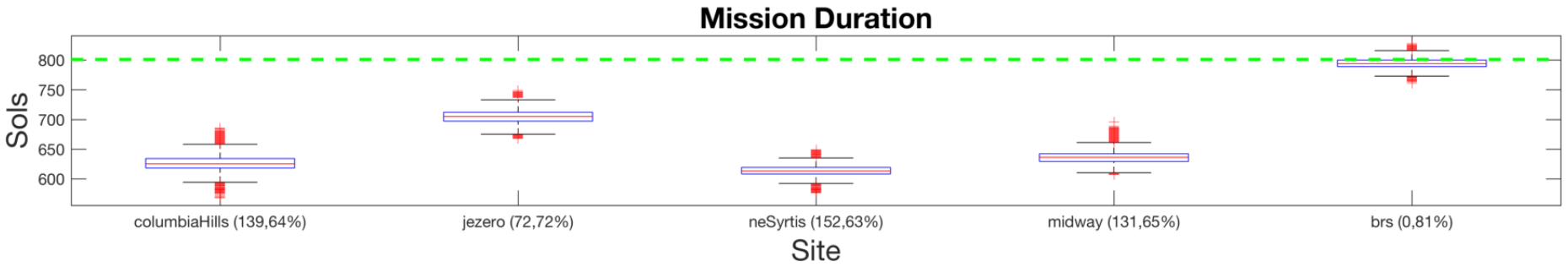
Site Environment



Drive Characteristics



Site-Specific Performance Comparison



- Results of mission performance monte-carlo modeling shown above.
  - Comparing landing site performance to Baseline Reference Scenario 80th-percentile mission duration (green-dashed line)

- Mission Performance Model Conclusions
  - ***All candidate landing sites meet or exceed BRS mission performance requirements***
  - A robust Mars Relay Network is critical to achieving Operational Efficiency necessary to meet mission performance requirements.

Mars 2020 Science Team Presentations

- developed by science team's landing site working group after multiple years of focused investigation
- intended to be a dispassionate presentation of site strengths, weaknesses, opportunities and uncertainties
- each presents a detailed mission scenario and notional sample cache to facilitate comparison

Importance of Extended Mission

The science community has indicated the need to acquire a cache of ~31 samples of Martian rock, regolith and blanks, with flexibility to "change our minds" and resample six of them (37 total samples).

SO:

The Mars 2020 Rover will carry 42 sample tubes, including five engineering spares.

BUT:

The Mars 2020 rover is designed to be capable of acquiring just 20 samples in the baseline mission.

AND:

20 does not equal 37 (nor even 31)

THUS:

To achieve the science goal, samples are expected to be collected in extended mission.

Importance of Extended Mission

Beyond the qualified mission duration of 1.5 Mars years, the likelihood of some time of rover failure or handicap rises.

- other than steady degradation of power available from the RTG and batteries, there are no currently known consumables or "breakpoints" at which operations become more challenged

Nevertheless, in assessing site value, more weight should be placed on science targets accessible within the rover's qualified 1.5 MY lifetime.

To accommodate this distinction, the site assessment criteria include separate questions related to the prime mission and the extended mission

Assessment Critera

The workshop should focus on science value rather than the still poorly defined potential sample return mission.

A. Prime Mission Assessment

For each landing site, evaluate the following criteria specifically in reference to the science that could be completed in the first 1.25 Mars years on the surface. Do not include extended mission opportunities in this part of your evaluation.

Criterion 1 (In-Situ Science):

The landing site includes an astrobiologically-relevant ancient environment and has geologic diversity with the potential to yield fundamental scientific discoveries when it is a) characterized for the processes that formed and modified the geologic record; and b) subjected to astrobiologically-relevant investigations (e.g., assessment of habitability and biosignature preservation potential). (scoring: 1=low potential, 5=high potential)

Criterion 2 (Returnable Cache Science):

A rigorously documented and returnable cache of rock and regolith samples assembled at this site has the potential to yield fundamental scientific discoveries if returned to Earth in the future. (scoring: 1=low potential, 5=high potential)

Criterion 3:
There is confidence in the assumptions, evidence, and any interpretive models that support the assessments for Criteria 1 and 2 for this site. (scoring: 1=low confidence, 5=high confidence).

Assessment Critera

B. Extended Mission Scenario Assessment

For each of the extended mission scenarios described at the workshop, evaluate the following criteria specifically in relation to the scientific knowledge and samples that would occur in the extended mission *beyond what is likely to be obtained in the first 1.25 Mars years*. Stated differently, evaluate the incremental scientific benefit of each extended mission scenario.

Criterion 1 (In-Situ Science):

The extended mission scenario has the potential to yield fundamental additional scientific discoveries using the rover payload. (scoring: 1=low potential, 5=high potential)

Criterion 2 (Returnable Cache Science):

Rock and regolith samples assembled in the extended mission have the potential to yield fundamental additional scientific discoveries if returned to Earth in the future. (scoring: 1=low potential, 5=high potential)

Criterion 3:
There is confidence in the assumptions, evidence, and any interpretive models that support the assessments for Criteria 1 and 2 for the extended mission. (scoring: 1=low confidence, 5=high confidence).

Backup

NE Syrtis Mission Performance Summary

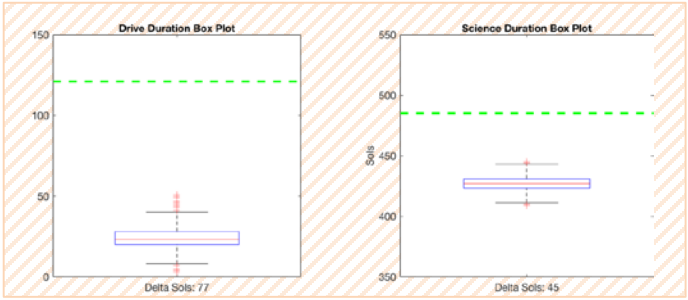
Jet Propulsion Laboratory
California Institute of Technology

Mars 2020 Project

Overall Mission Performance

BRS
80th percentile

Partial Model Results



deltaSols (80th percentile) = # unconstrained sols from BRS mission
adjusted Ops Eff % (80th percentile) = Ops Efficiency needed for 1.25 MY mission

Science Scenario Details

2 ROIs

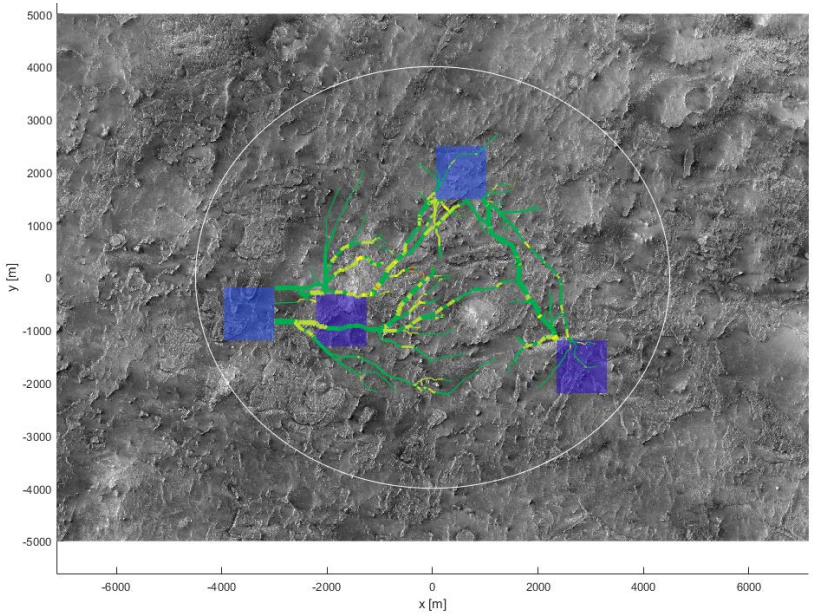
- ROI #1 (any ROI box)
  - **6 samples**
  - 2 campaigns with 2 units each, separated by 200 meters
- ROI #2 (any ROI box)
  - **6 samples**
  - ROI 2 will be separated by at least 1 km from ROI 1
  - 2 campaigns with 2 units each, separated by 200 meters

4 Waypoints

- Early/Mid-Noachian Clay-rich Basement (throughout ellipse)
  - **3 Rock samples** from waypoints along the strategic route between ROIs separated by at least 500 meters
- Regolith (throughout ellipse)
  - **1 Regolith sample** from wherever

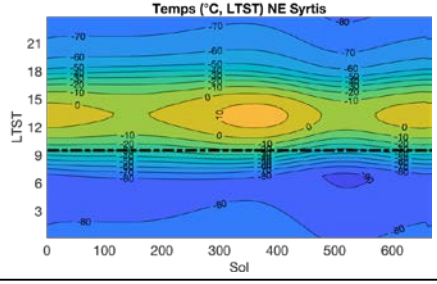
+ 4 Witness Tubes

Drive routes to ROI locations

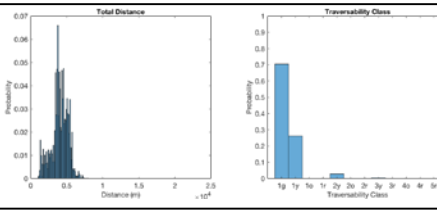


Site Environment

	1.25 MY Environment Bin % (coldest) 1	2	3	4	5	6 (warmest)
NE Syrtis	0%	0%	21%	57%	22%	0%



Drive Characteristics



Midway Mission Performance Summary

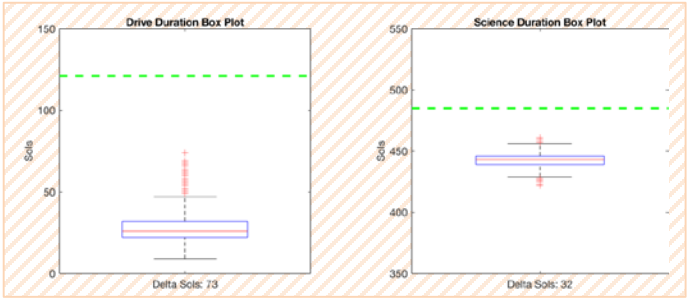
Jet Propulsion Laboratory
California Institute of Technology

Mars 2020 Project

Overall Mission Performance

BRS
80th percentile

Partial Model Results



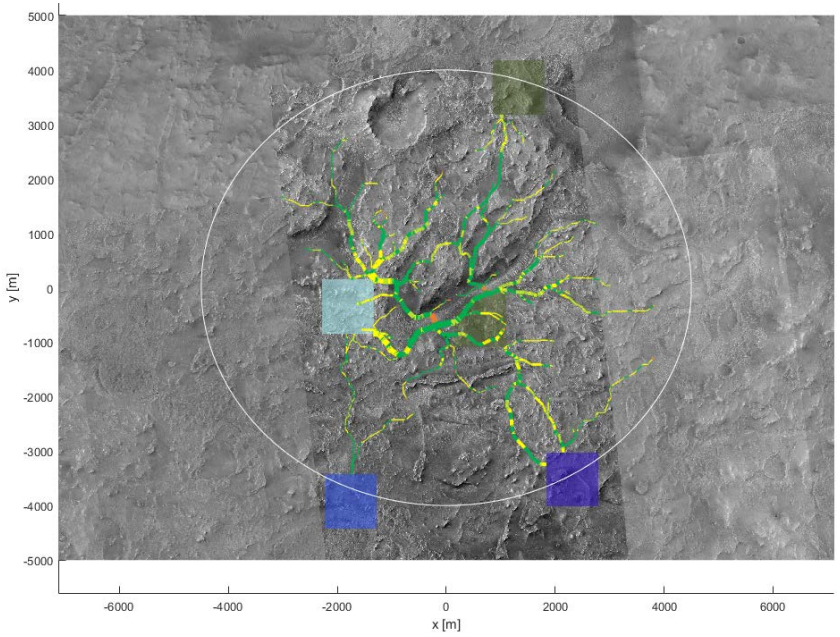
deltaSols (80th percentile) = # unconstrained sols from BRS mission
adjusted Ops Eff % (80th percentile) = Ops Efficiency needed for 1.25 MY mission

Science Scenario Details

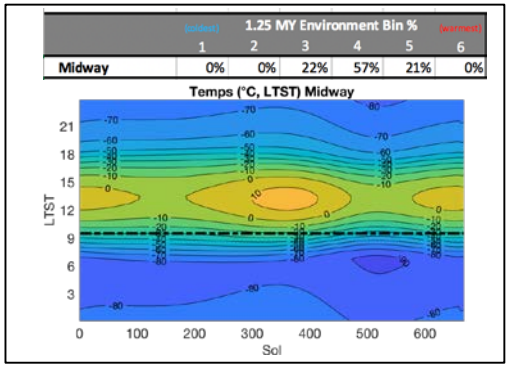
2 ROIs
- ROI #1 (any ROI box)
  - **7 samples**
  - 2 campaigns with 2 units each
  - ROI #2 (any ROI box)
  - **7 samples**
  - ROI 2 will be separated by at least 1 km from ROI 1
  - 2 campaigns with 2 units each
- **4 Waypoints**
  - **1 Rock samples**
  - **1 Regolith sample**

+ 4 Witness Tubes

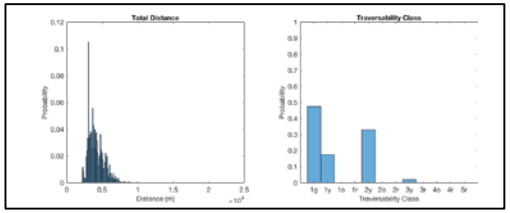
Drive routes to ROI locations



Site Environment



Drive Characteristics



Columbia Hills Mission Performance Summary

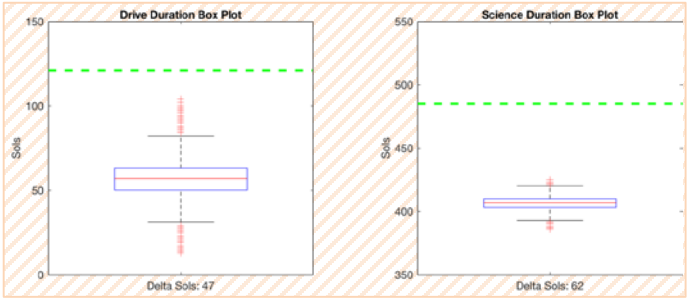
Jet Propulsion Laboratory
California Institute of Technology

Mars 2020 Project

Overall Mission Performance

BRS
80th percentile

Partial Model Results



deltaSols (80th percentile) = # unconstrained sols from BRS mission
adjusted Ops Eff % (80th percentile) = Ops Efficiency needed for 1.25 MY mission

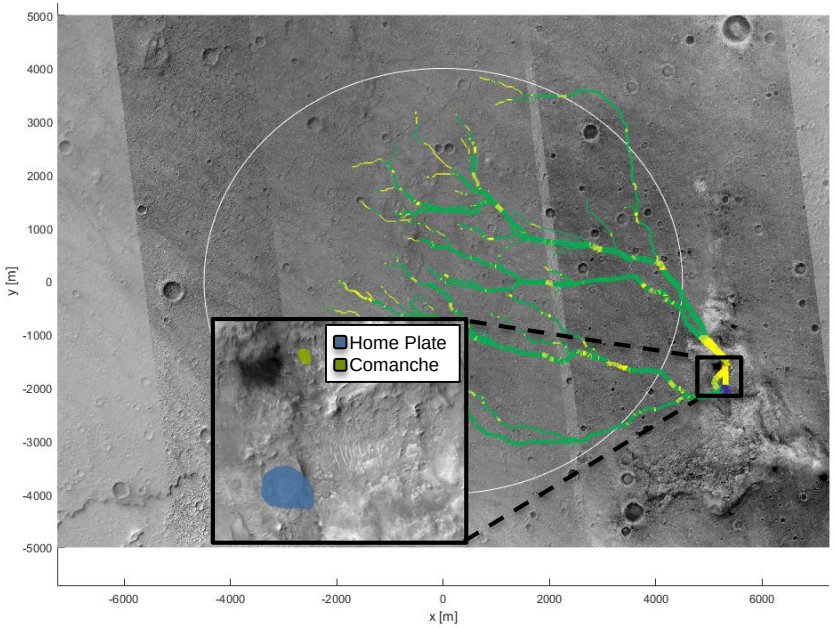
Science Scenario Details

2 ROIs
- Home Plate
  - **8 samples**
  - 2 campaigns with 3 units each
  - 2 regolith samples
- Comanche Carbonates
  - **5 samples**
  - 1 Campaign with 2 units

3 Waypoints
- Plains Basalt (throughout ellipse)
  - **2 samples**
  - 2 rock waypoints
- Regolith (throughout ellipse)
  - **1 sample**
  - 1 regolith waypoint

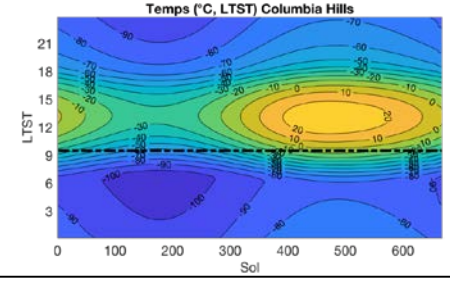
+ 4 Witness Tubes

Drive routes to ROI locations



Site Environment

	1.25 MY Environment Bin % (coldest)					(warmest)
	1	2	3	4	5	6
Columbia Hills	0%	31%	15%	11%	16%	28%



Drive Characteristics