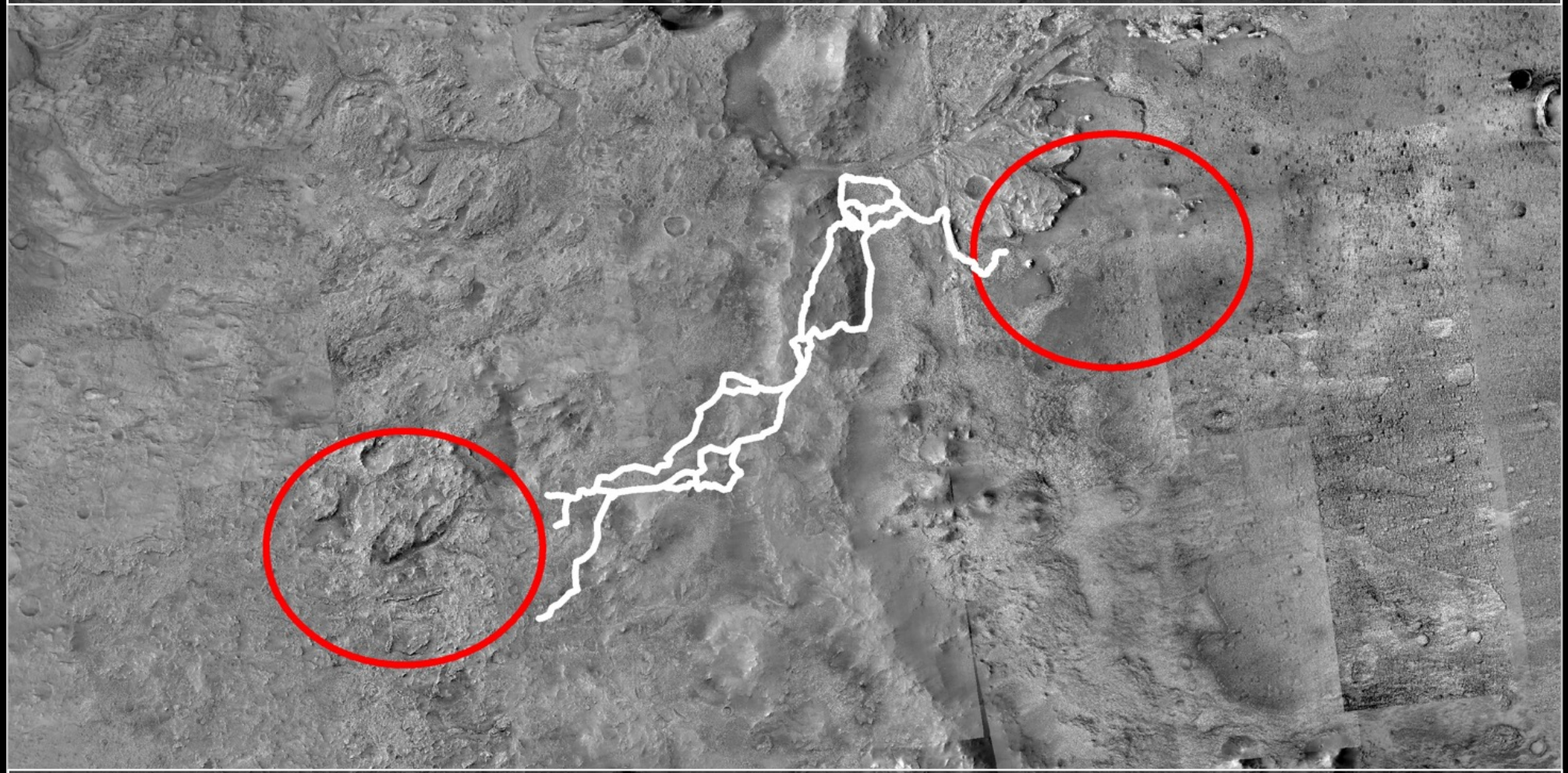
Jezero-Midway interellipse traverse mission concept

Strong MSR potential: high geologic diversity, diverse habitable environments, broad window of martian history



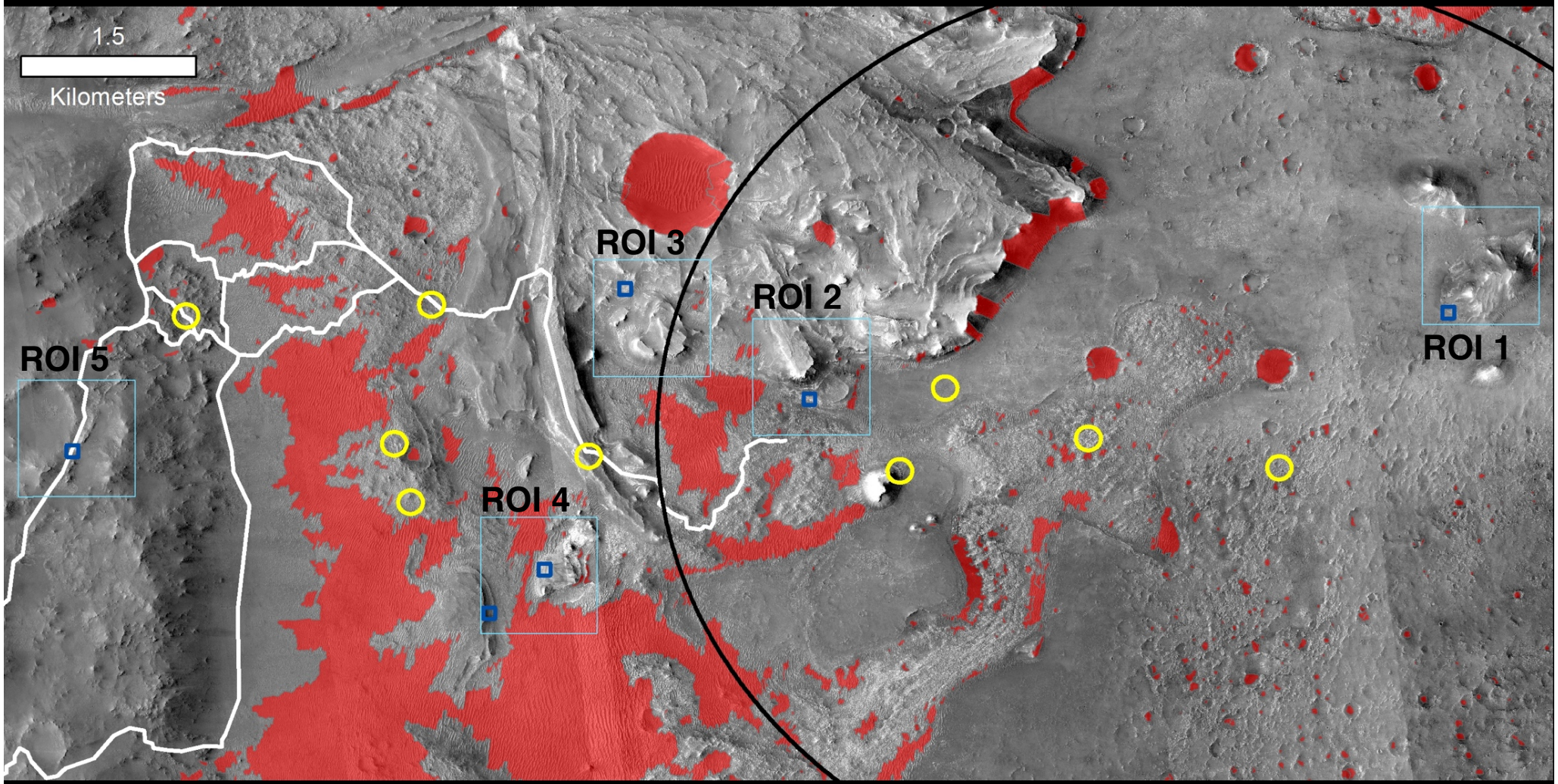
The Project Science Team

Ken Farley[1], Katie Stack Morgan[2], Ken Williford[2]
[1]California Institute of Technology
[2]Jet Propulsion Laboratory, California Institute of Technology
on behalf of the Mars 2020 Science Team

Fourth Landing Site Selection Workshop for Mars 2020, October 18, 2018

Jet Propulsion Laboratory
California Institute of Technology

Jezero notional scenario relative to distribution of inescapable hazards



Inescapable hazards

Traverse vetted by M2020 subject matter experts

Notional ROIs (1 km^{2})

Notional campaigns (100 m^{2})

Notional waypoints (single location stops)

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A bold and disciplined traverse connecting and comparing through scientific exploration and sampling a wide variety of ancient martian environments including

aqueously altered primordial crust;

an impact crater that exhumed and energized this crust and its subsurface water, potentially generating habitable environments;

and a post-impact fluvio-lacustrine system that concentrated the compositional diversity of its watershed and preserved a record of interactions between the solid planet, surface and subsurface water, atmosphere, and potentially life.

Goal that provides enduring focus to the mission

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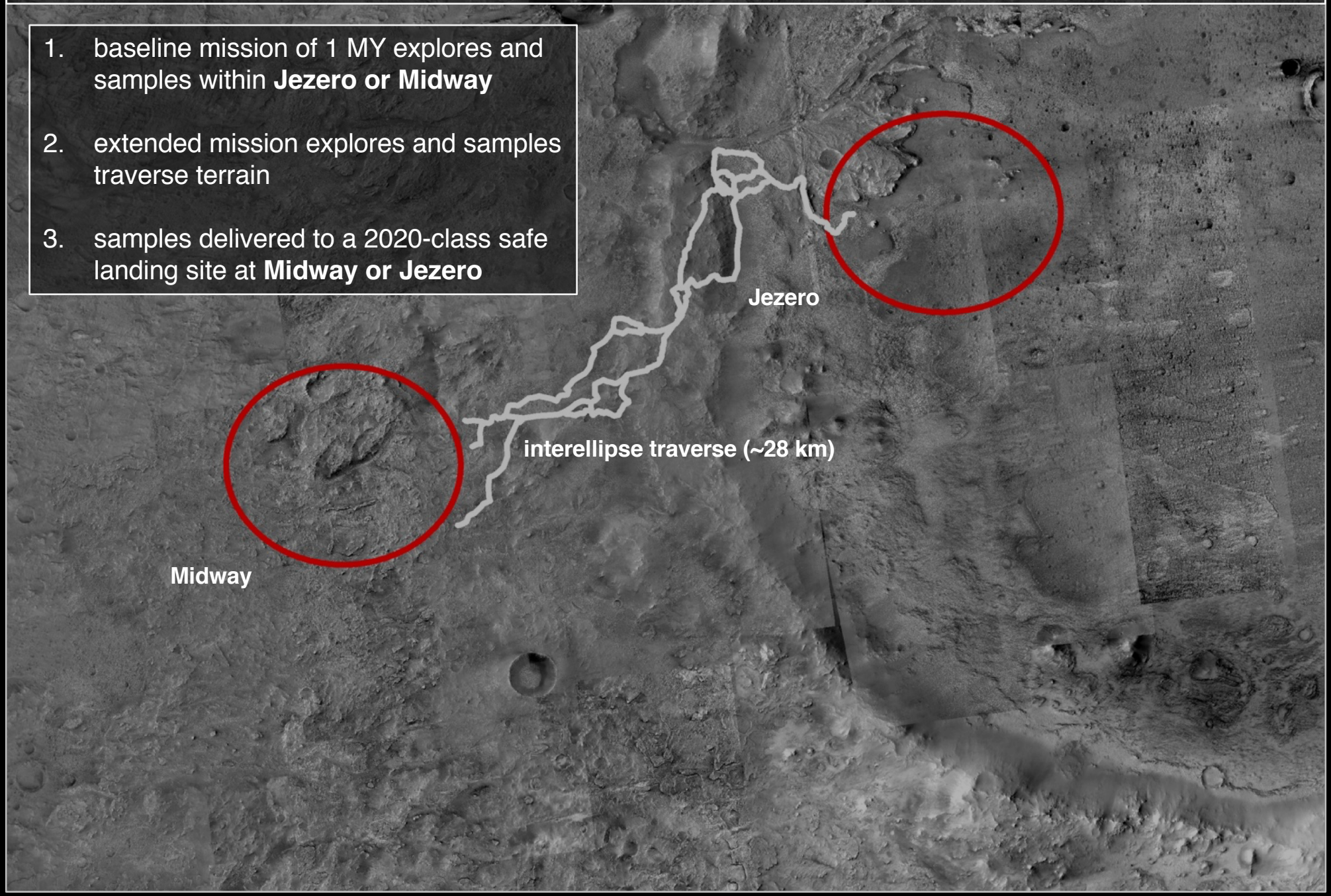
1. baseline mission of 1 MY explores and samples within **Jezero or Midway**
2. extended mission explores and samples traverse terrain
3. samples delivered to a 2020-class safe landing site at **Midway or Jezero**



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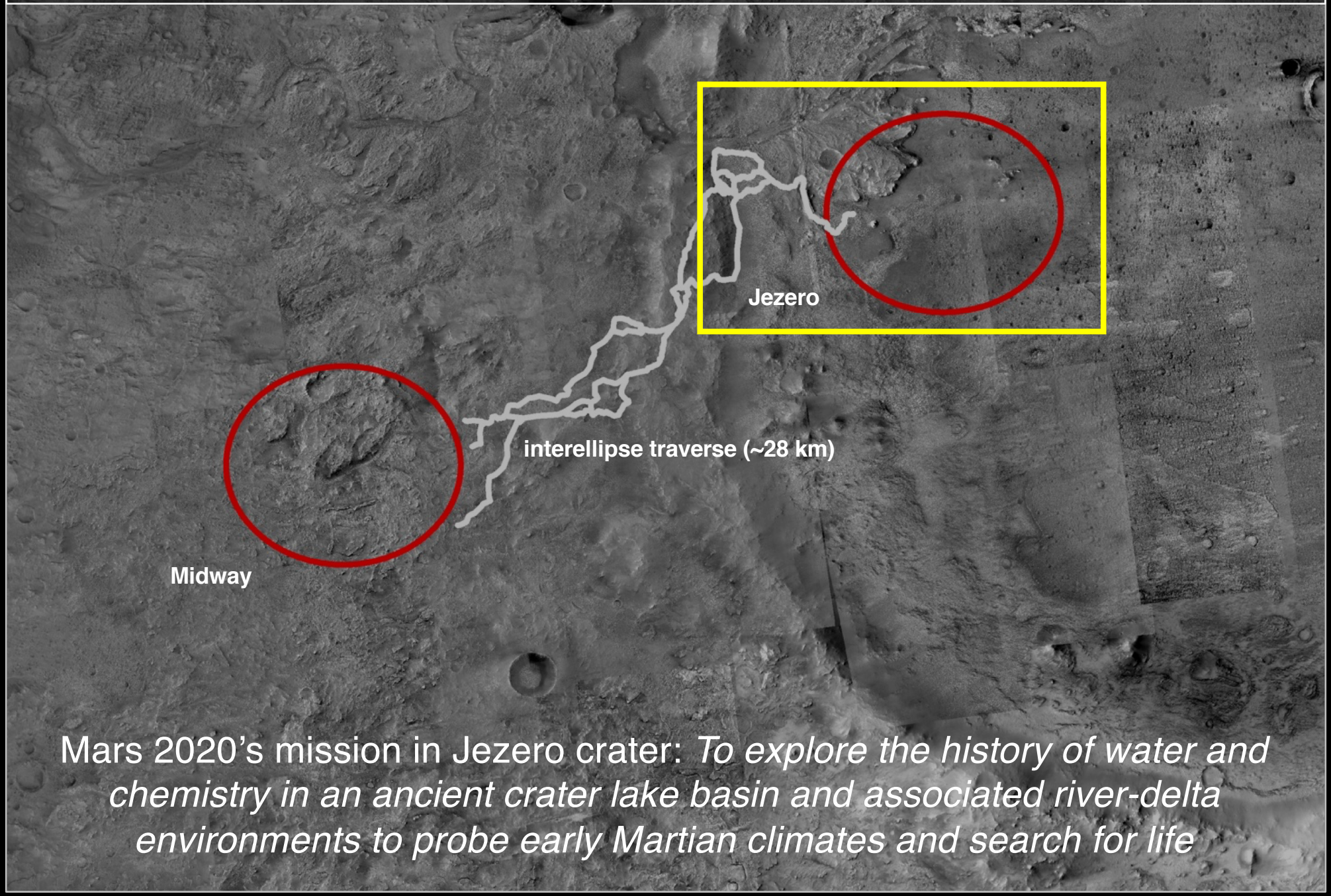

Mars 2020's mission in Jezero crater: *To explore the history of water and chemistry in an ancient crater lake basin and associated river-delta environments to probe early Martian climates and search for life*

Jezero-Midway interellipse traverse mission concept

Strong MSR potential: high geologic diversity, diverse habitable environments, broad window of martian history

Jezero

- habitable ancient environment with high facies diversity
- strong biosignature preservation potential via diverse, well-understood pathways
- paleoclimate records from ‘critical zone’ interface of atmosphere, surface water, and sediments
- coarse-grained units that concentrate geologic diversity of watershed
- mature models to guide exploration and sampling

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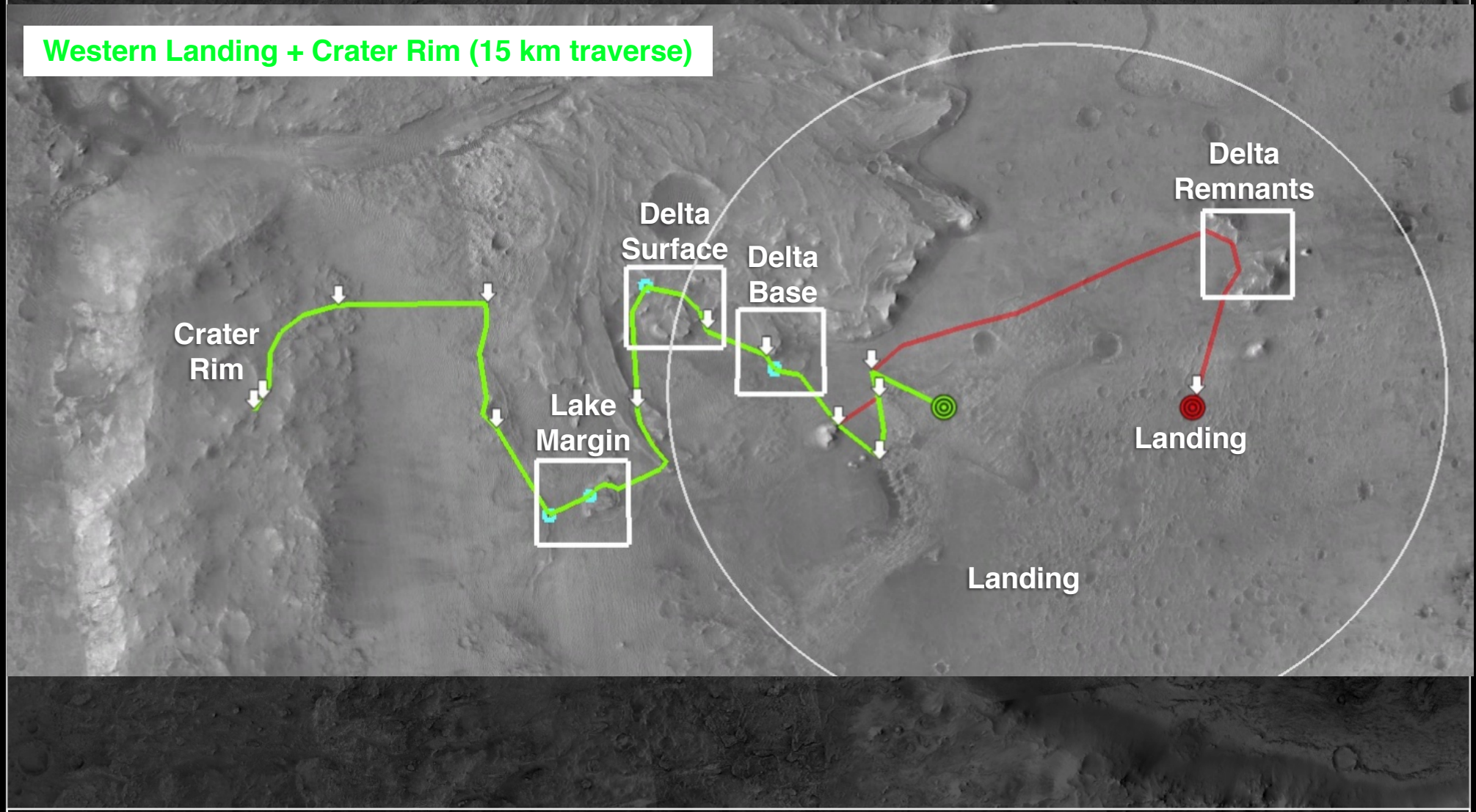

Notional Jezero mission

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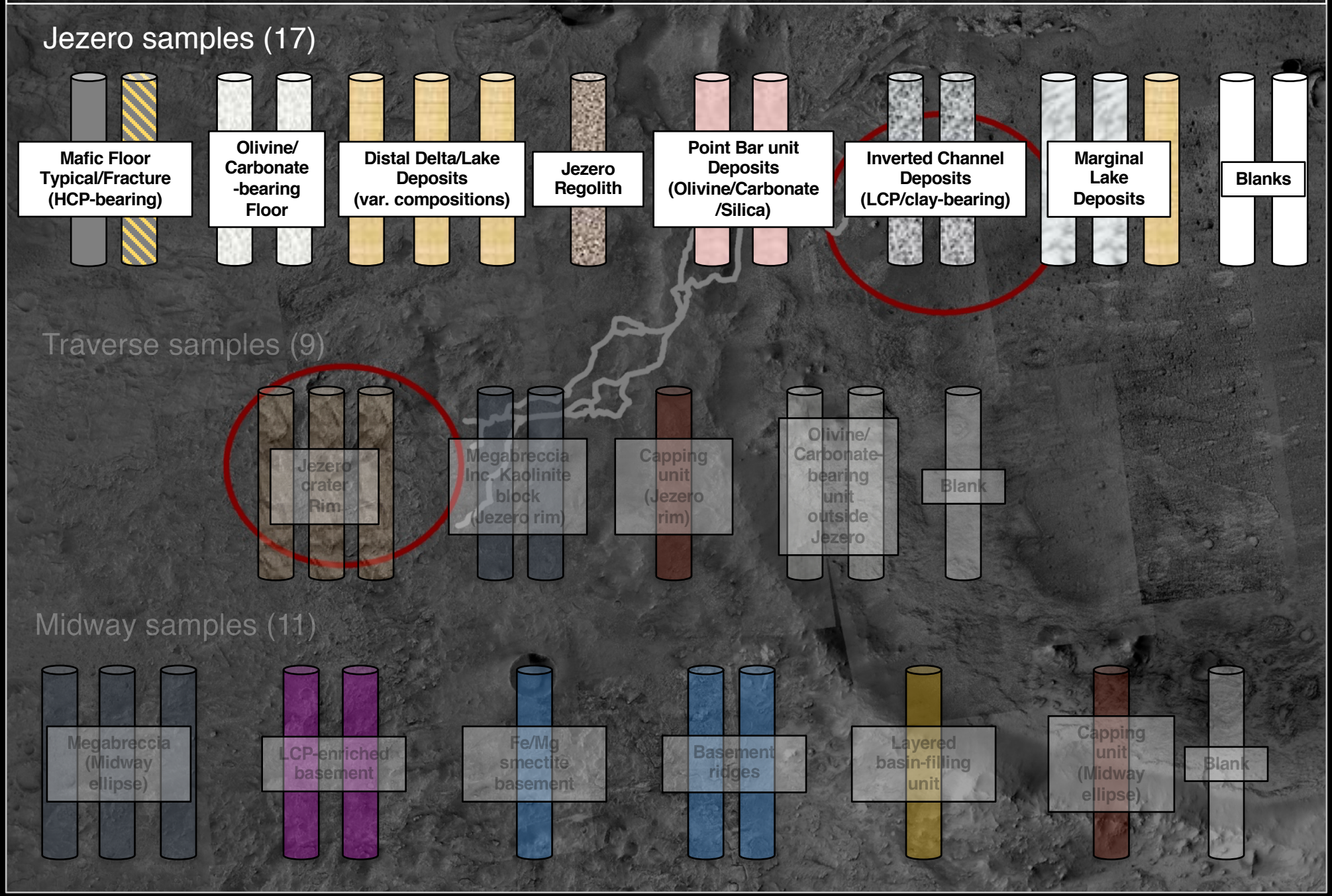

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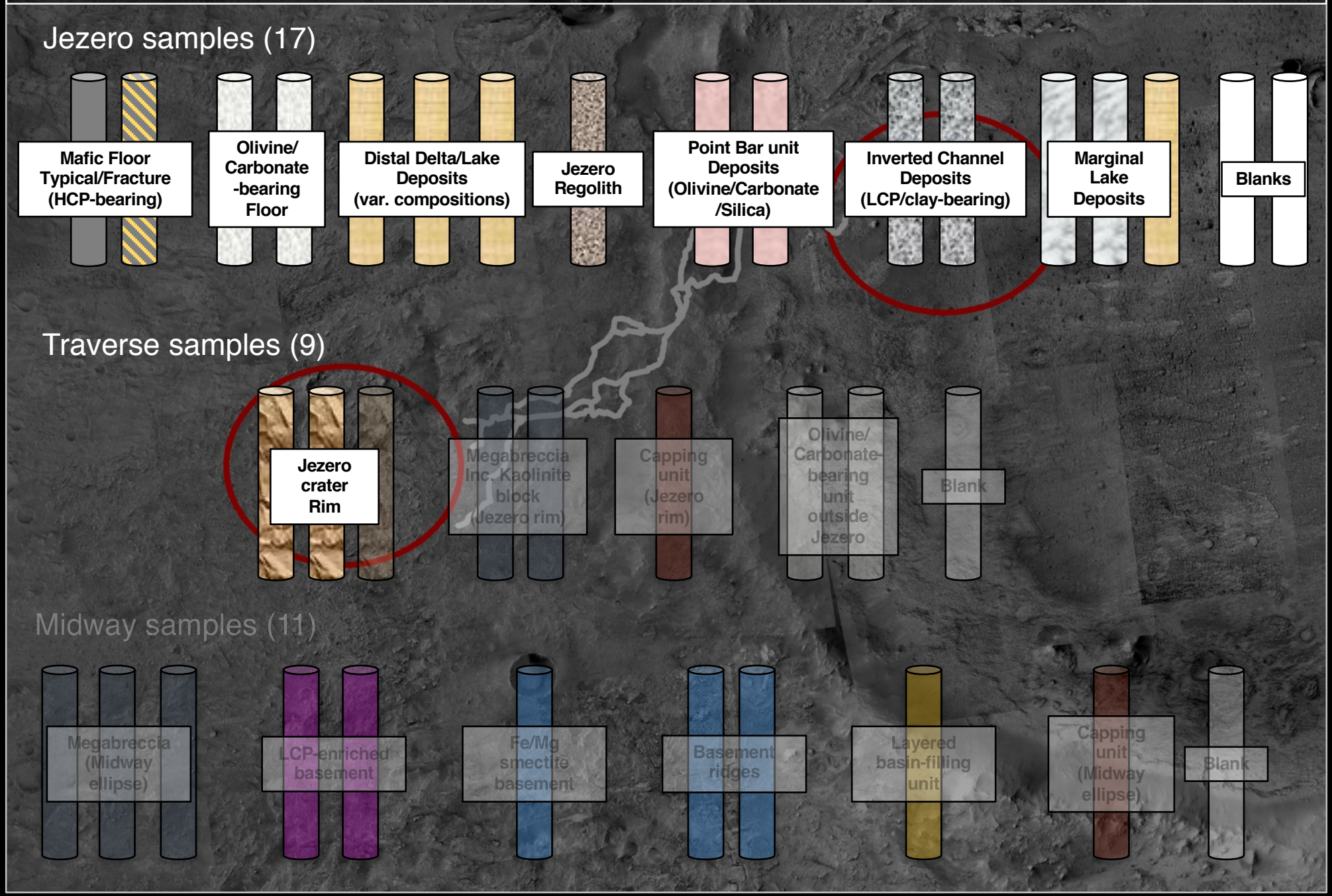

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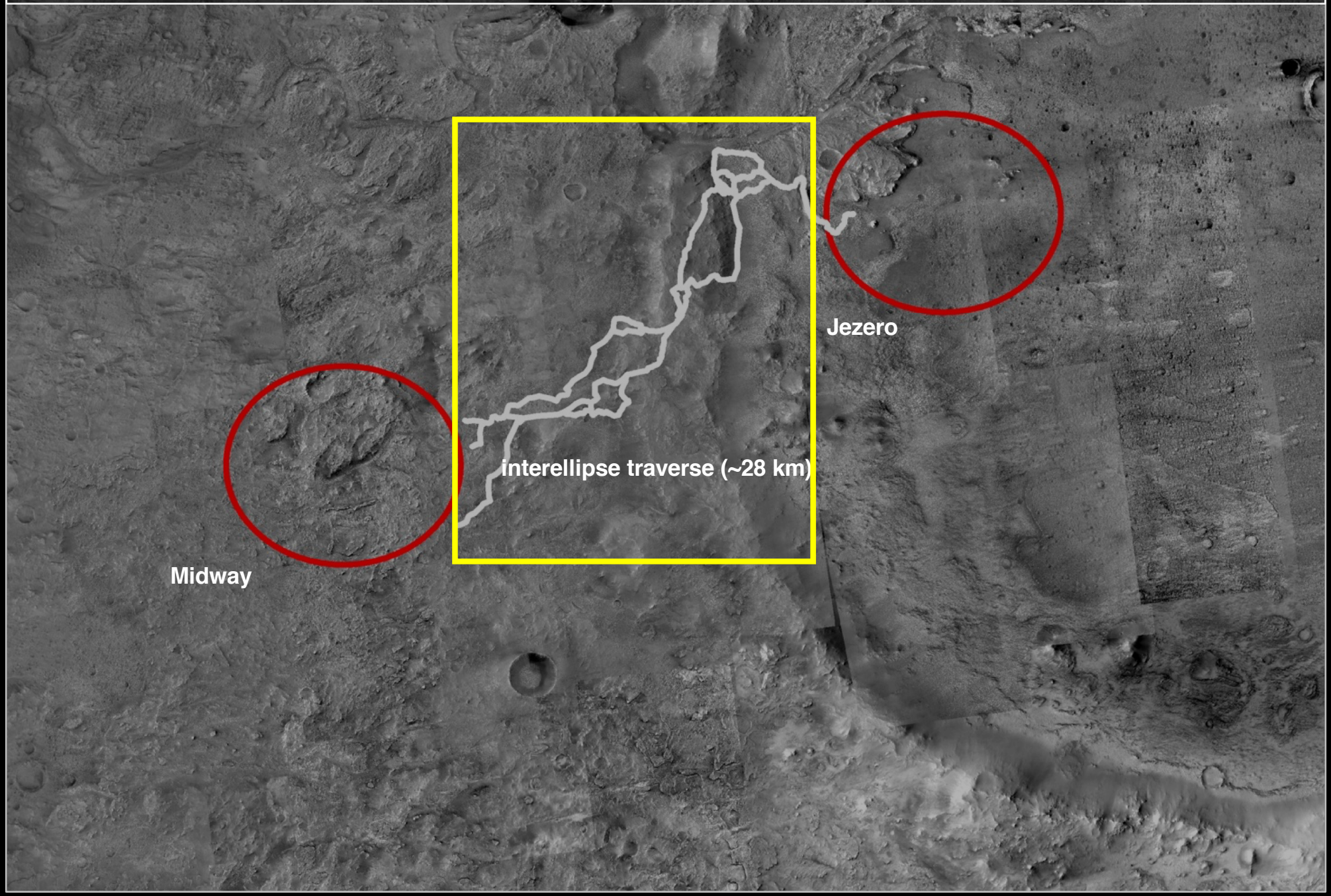

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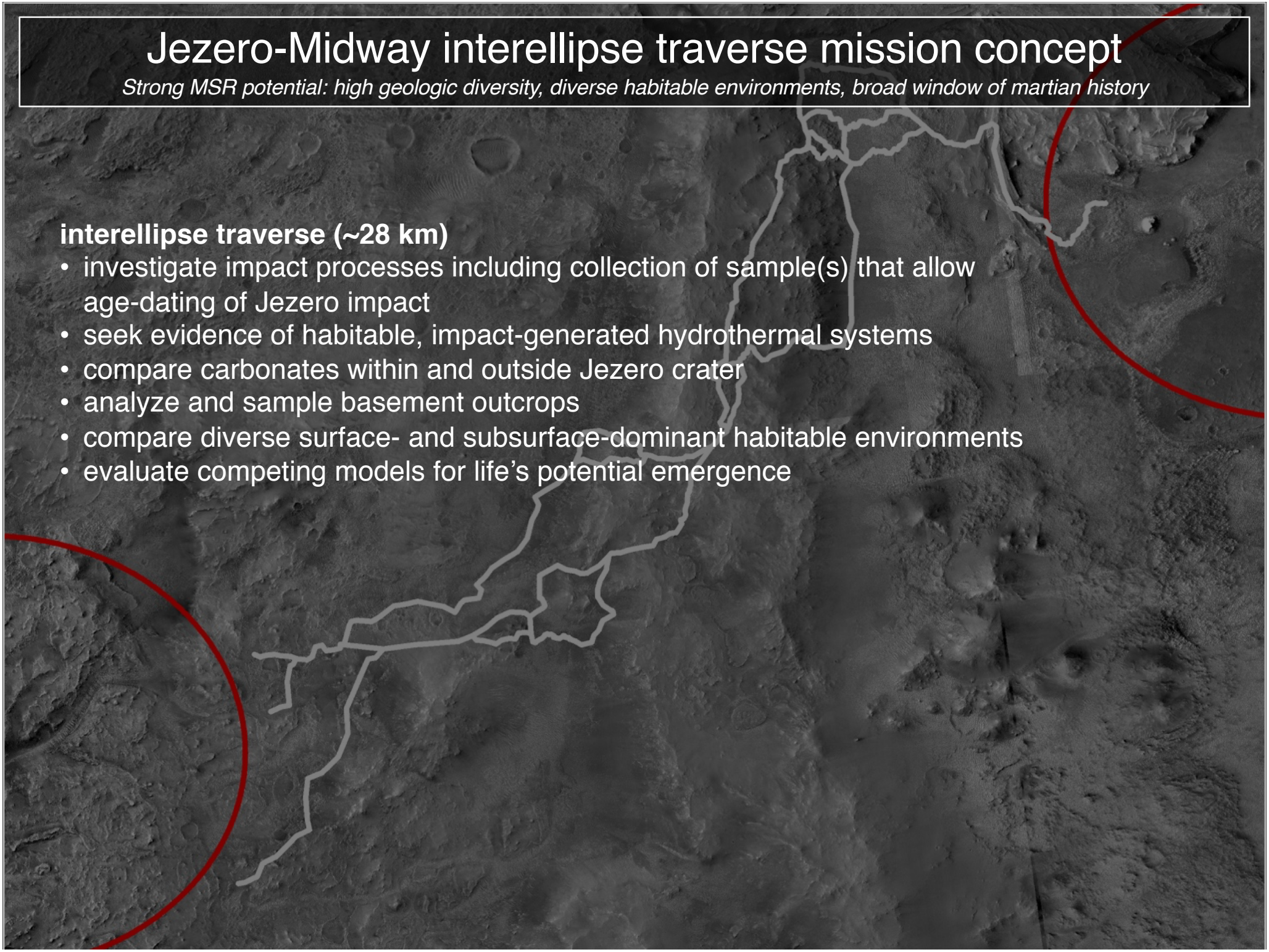

interellipse traverse (~28 km)

- investigate impact processes including collection of sample(s) that allow age-dating of Jezero impact
- seek evidence of habitable, impact-generated hydrothermal systems
- compare carbonates within and outside Jezero crater
- analyze and sample basement outcrops
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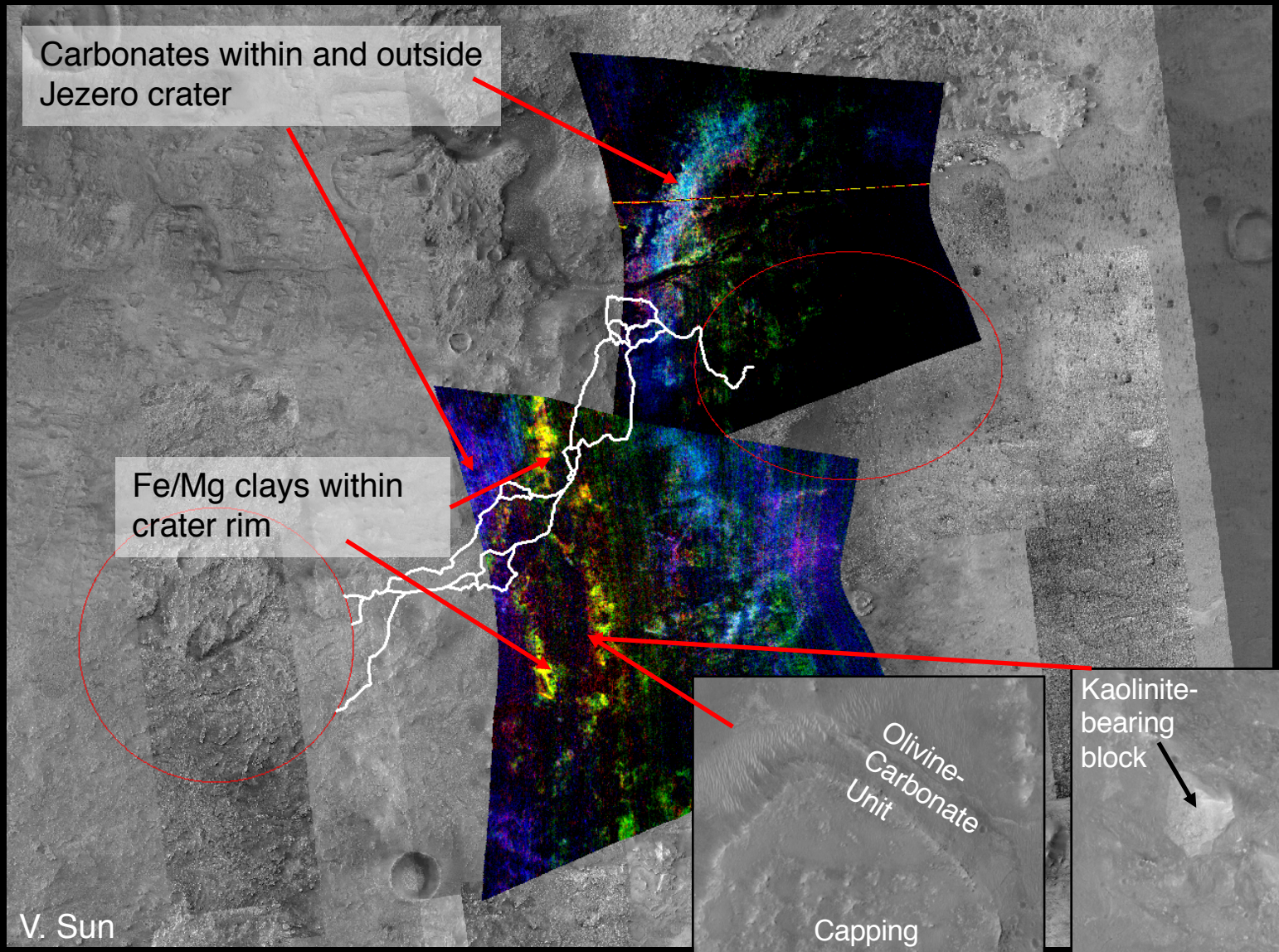
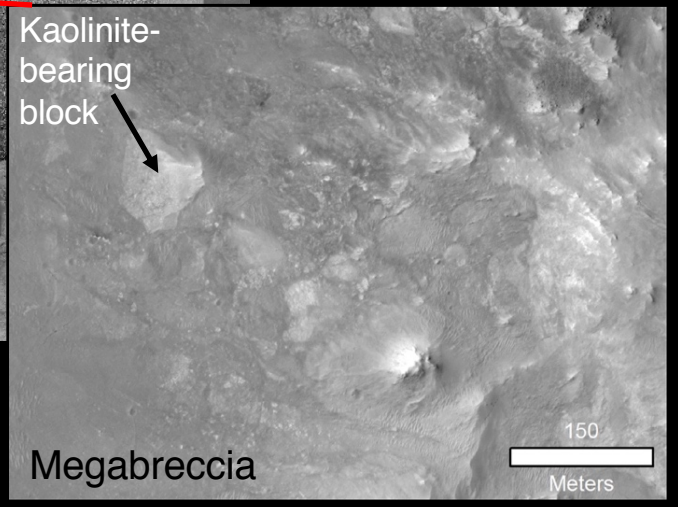


CRISM Parameter Stretch

R: BD1900
G: D2300 (Fe/Mg clays and carbonates)
B: Min2295_2480 (Carbonates)

Carbonates: blue/purple
Fe/Mg clays: yellow/green



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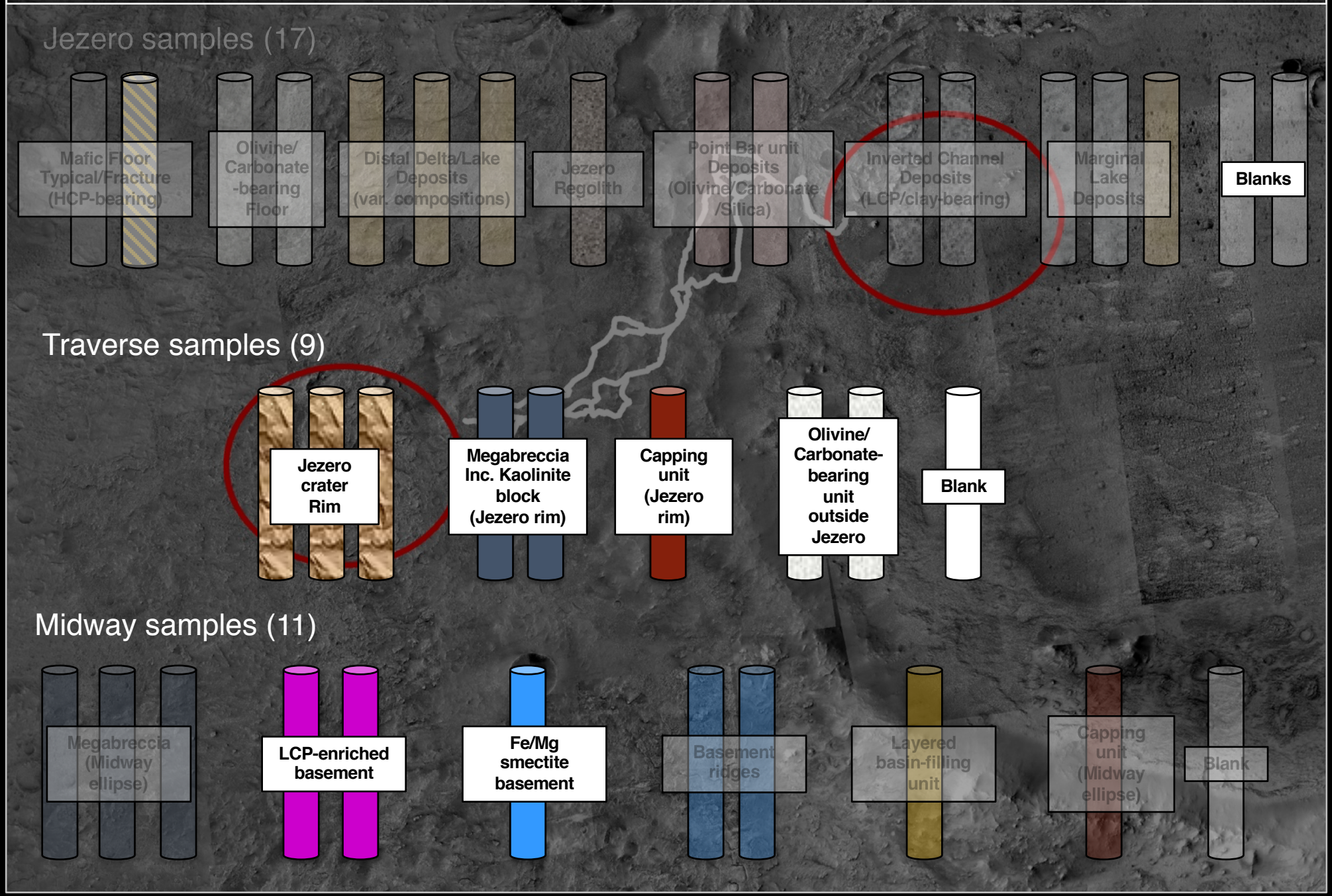

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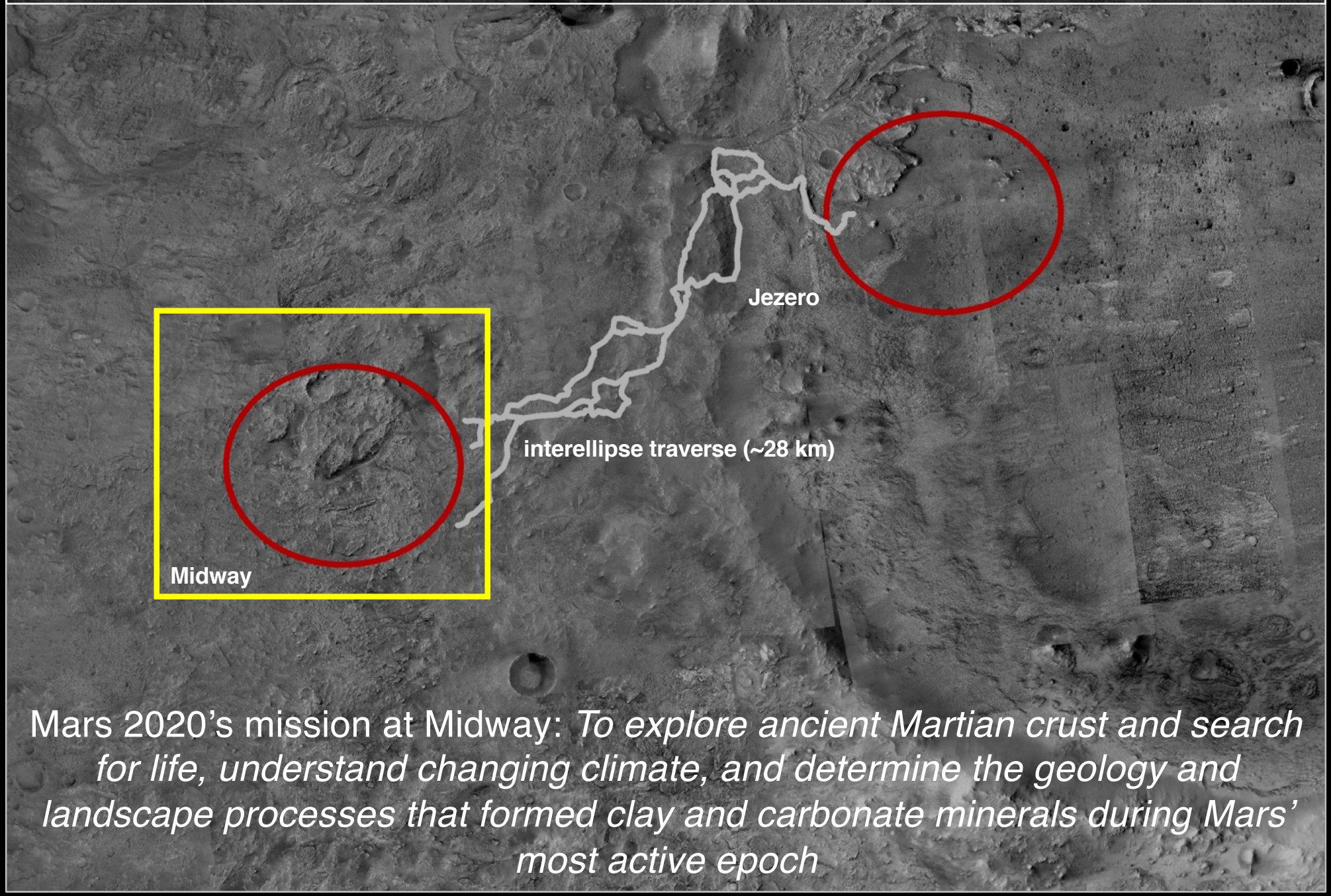

Mars 2020's mission at Midway: *To explore ancient Martian crust and search for life, understand changing climate, and determine the geology and landscape processes that formed clay and carbonate minerals during Mars' most active epoch*

Jezero-Midway interellipse traverse mission concept

Strong MSR potential: high geologic diversity, diverse habitable environments, broad window of martian history

Midway

- diverse crustal formation and alteration processes represented
- opportunity to age-date Isidis impact
- basement units represent extremely ancient, previously unexplored terrain
- potential rendezvous between M2020 and follow-on mission at Midway
- valuable post-MSR science opportunities far to the south

Jezero-Midway interellipse traverse mission concept

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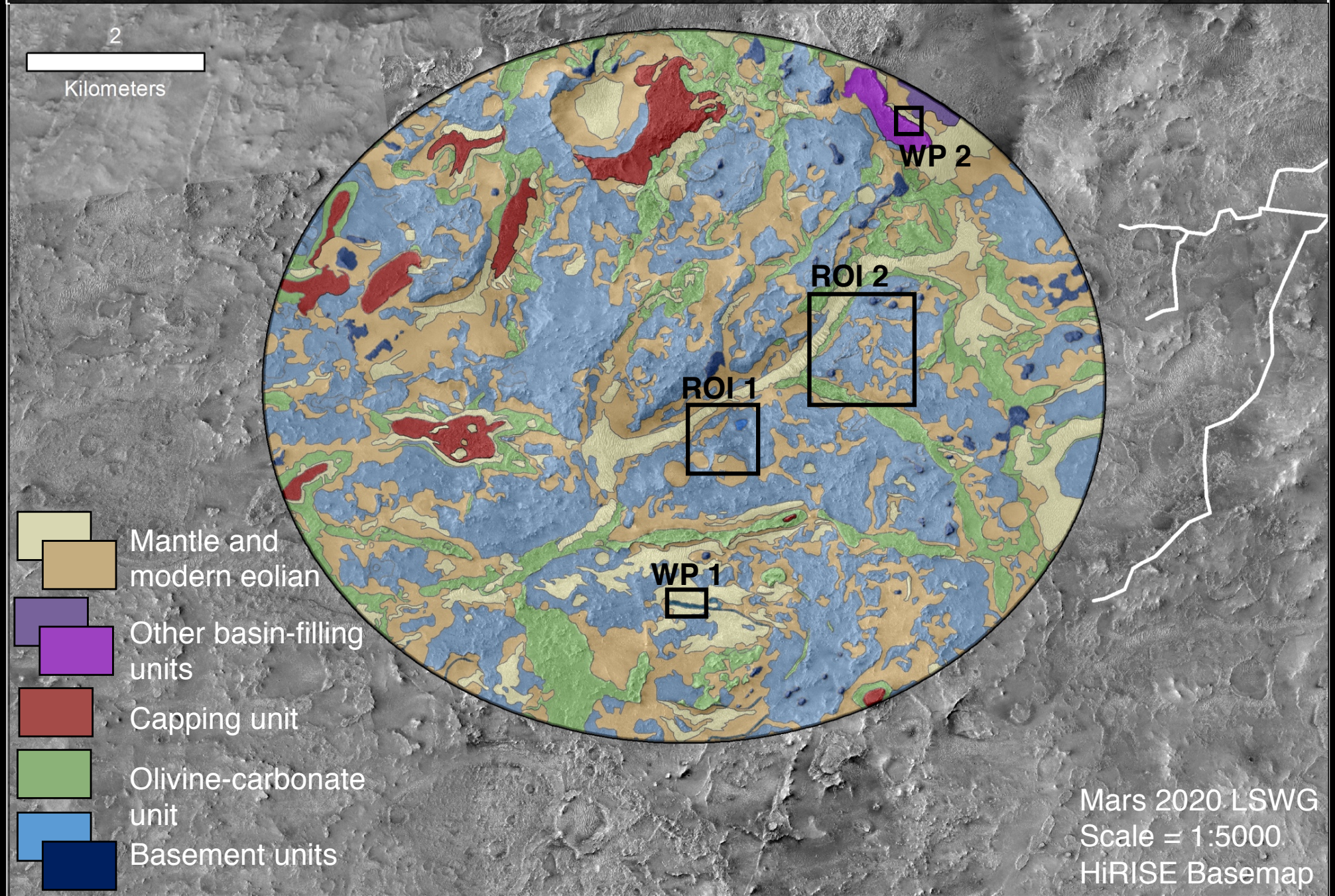

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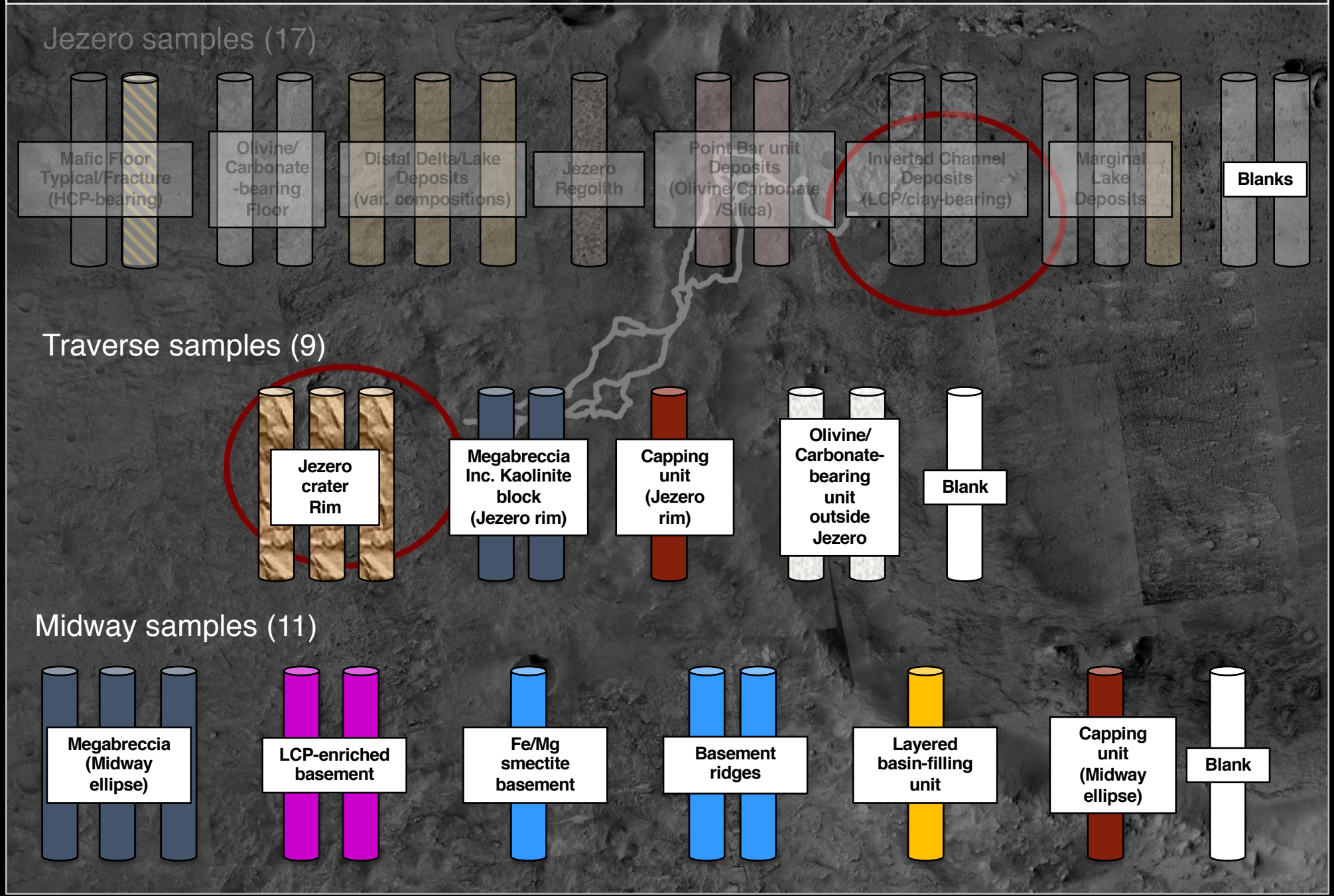

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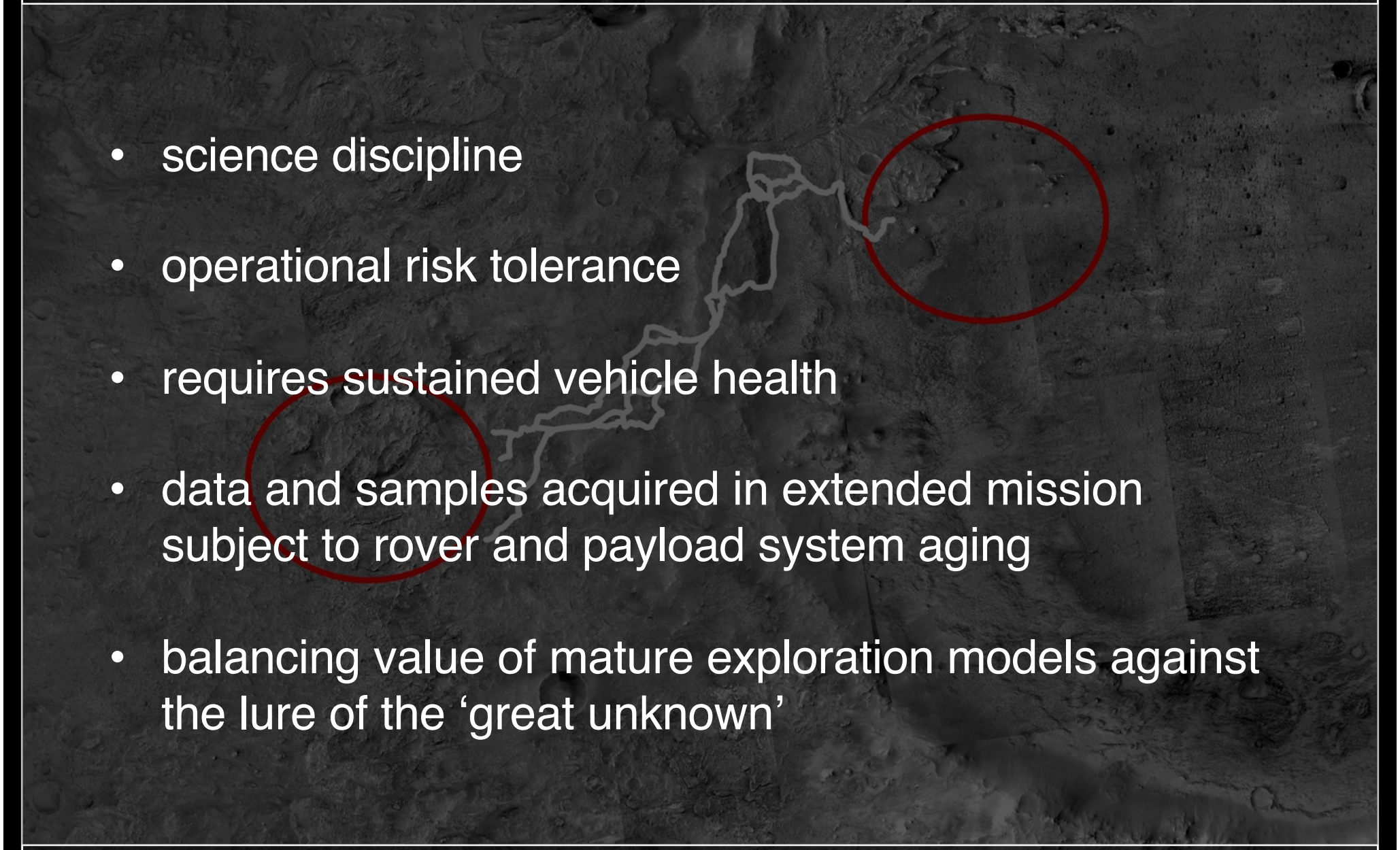


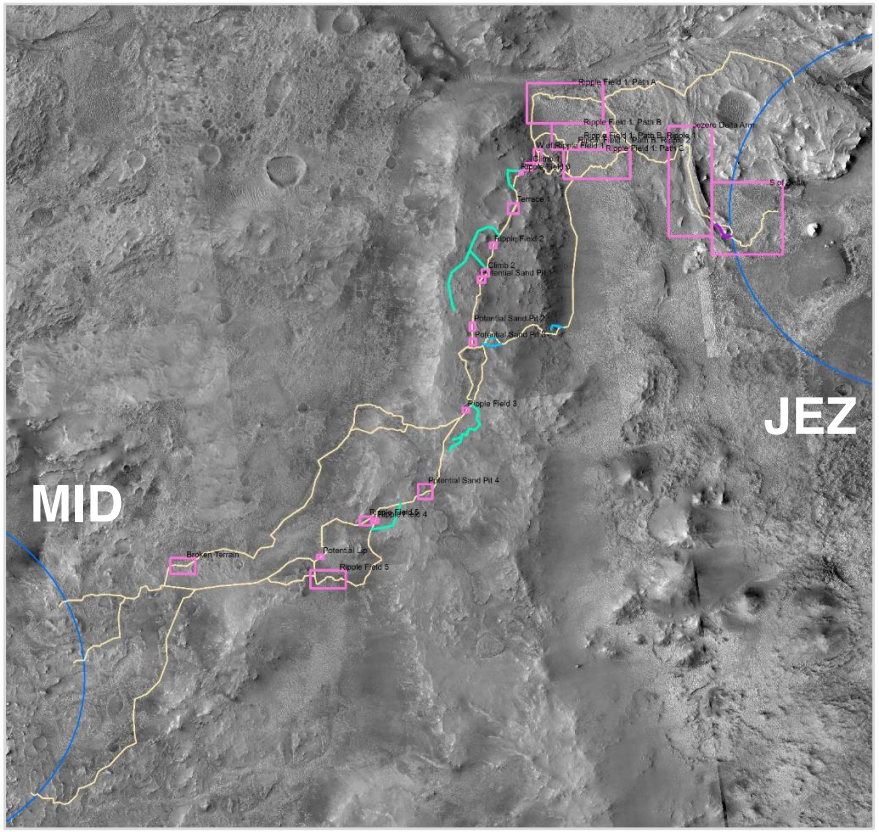
- science discipline
- operational risk tolerance
- requires sustained vehicle health
- data and samples acquired in extended mission subject to rover and payload system aging
- balancing value of mature exploration models against the lure of the ‘great unknown’

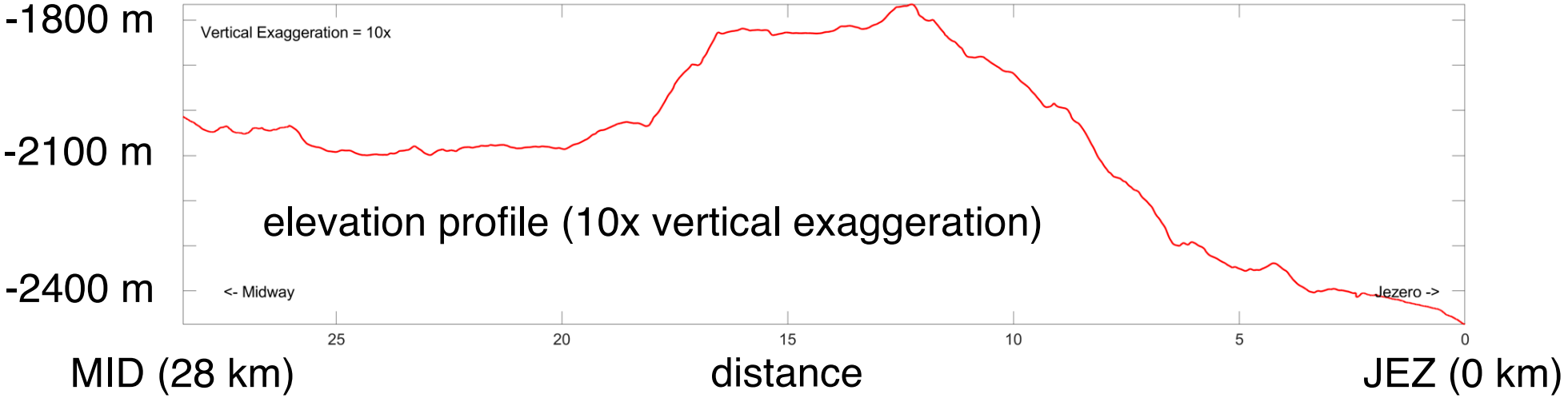
Key Concerns

Jezero-Midway interellipse traverse mission concept

Strong MSR potential: high geologic diversity, diverse habitable environments, broad window of martian history

- Traverse routes from Jezero to Midway identified and reviewed for feasibility by multiple JPL subject matter experts
- Two consensus conclusions:
- *Based on available visible images and slope maps, the M2020 rover would likely be able to traverse between the Jezero and Midway ellipses.*
- *To our current level of knowledge of the terrain and the vehicle's capabilities, there is no appreciable difference in the ease of traversability between Jezero>Midway vs. Midway>Jezero.*



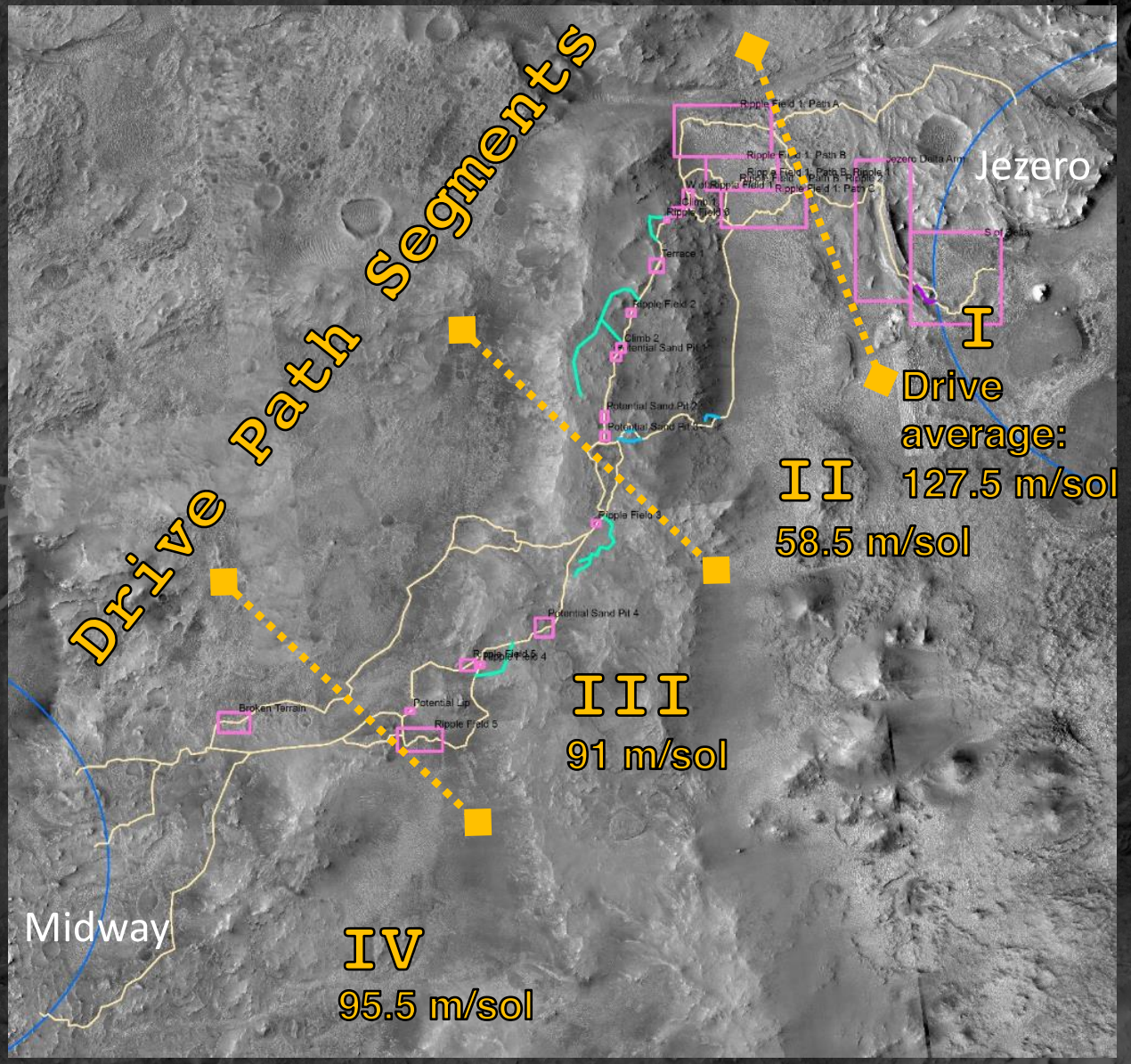


Jezero-Midway interellipse traverse mission concept

Strong MSR potential: high geologic diversity, diverse habitable environments, broad window of martian history

Traverse duration estimate between the two ellipses:

401 sols



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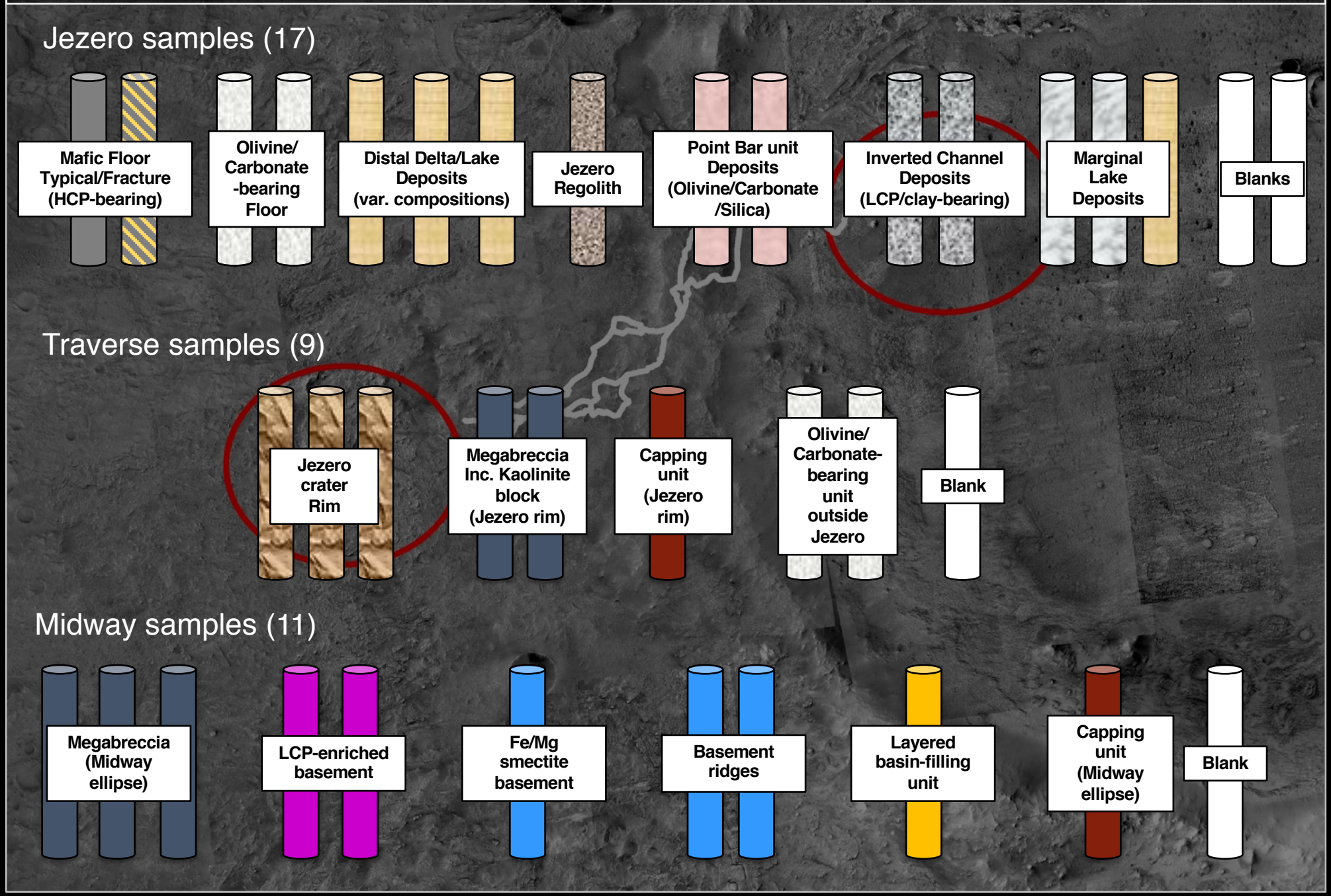

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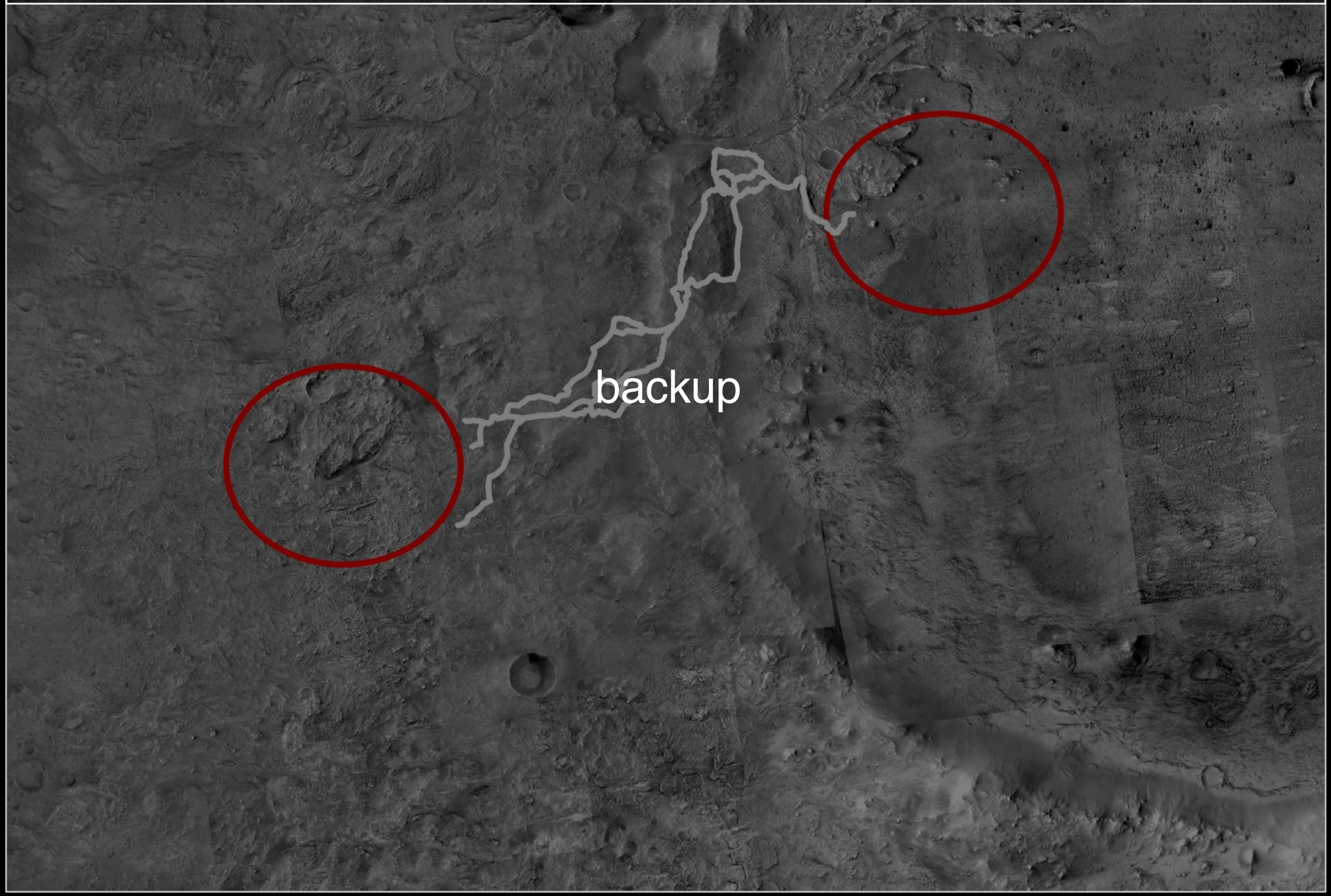

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Acknowledgements

- Mars 2020 science team
- Mars 2020 EDL team (landing ellipse identification and safety analysis)

- Traverse identification
  - N. Williams
  - Lauren Berger
  - M. Golombek

- Mobility engineering assessment (coordinated by Nathan Williams and Lauren Berger)
  - Matt Heverly
  - Erisa Stilley
  - Frank Hartman
  - Rich Rieber
  - Matt Golombek

- Mission performance and duration assessment
  - Rob Lange
  - Travis Wagner
  - Hiro Ono
  - Nathan Williams
  - Sarah Milkovich
  - others

Jezero-Midway interellipse traverse mission concept

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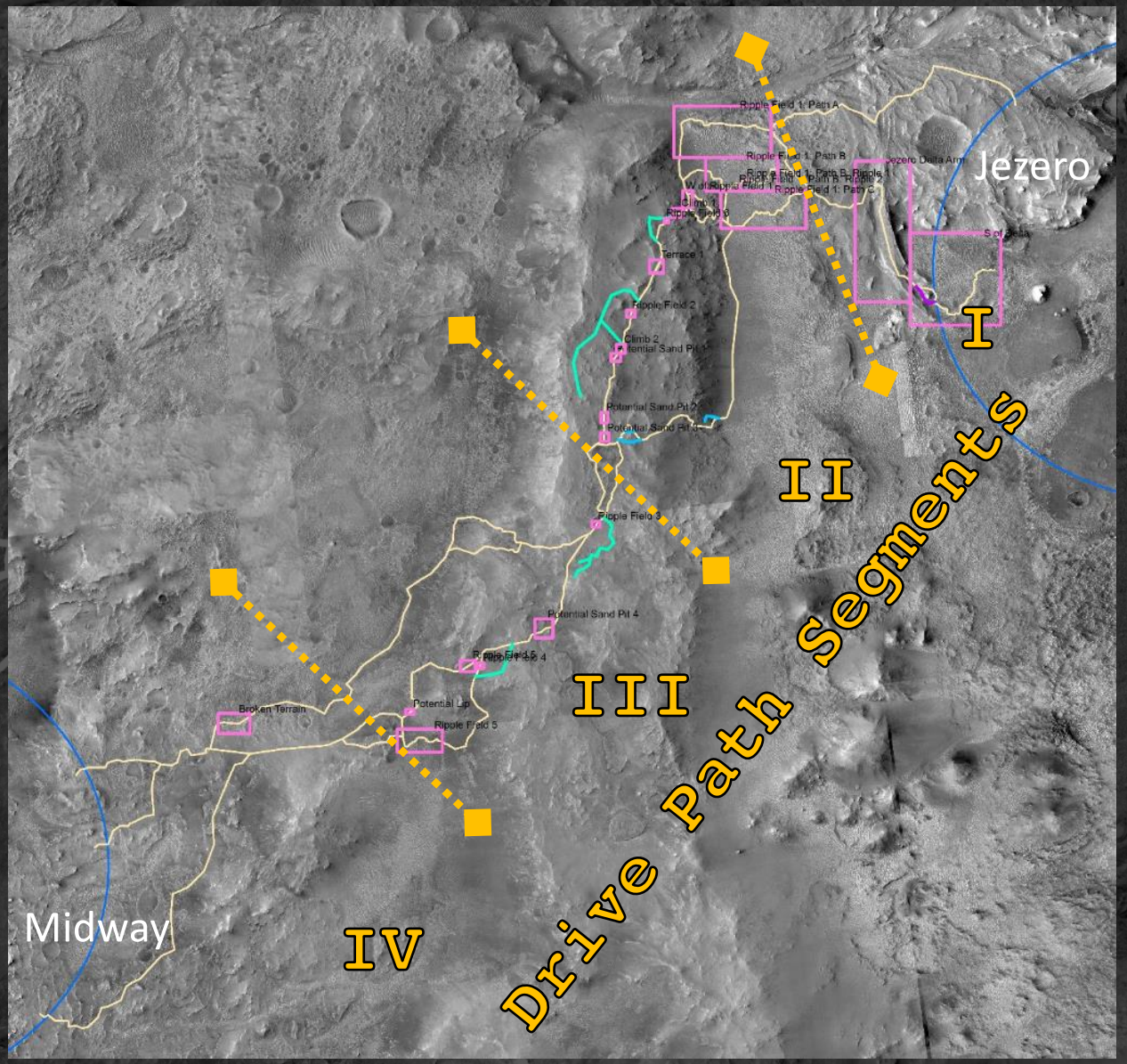
- Mission Planning

  Segment I
  - Terrain appears easy going until the bottom of the crater rim
  - Distance ~ 7 km

  Segment II
  - Difficult terrain, climbing and crossing the Jezero crater rim
  - Distance ~ 5 km

  Segment III
  - Intermediate terrain difficulty, atop the crater rim
  - Distance ~ 6 km

  Segment IV
  - Normal terrain
  - Distance ~10 km
  - Drive likely to occur late in EM, when Long Drive performance is expected to be impacted by available rover energy



Qualitative Traverse Assessments

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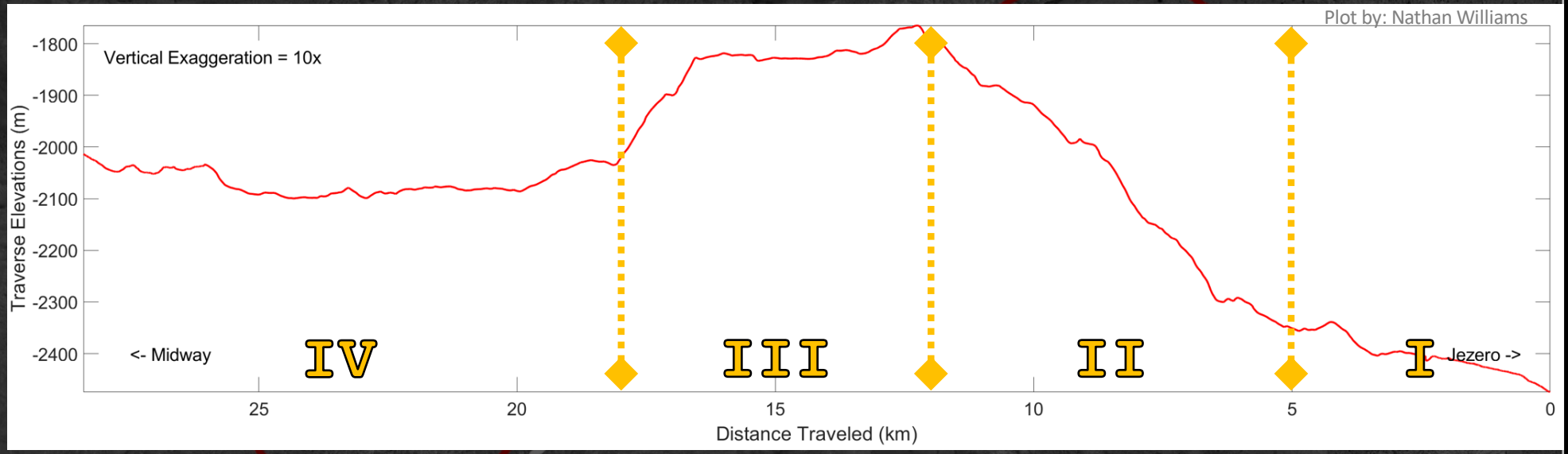

Drive Path Segments

Drive Path Segments

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		Drive Segment I	Drive Segment II	Drive Segment III	Drive Segment IV
Path Distance (m)		5,000	7,000	6,000	10,000
Path Inefficiency + Slip		20%	25%	22%	18%
Commanded Odometry (m)		6,000	8,750	7,320	11,800
Terrain Difficulty		Normal	Difficult	Intermediate	Normal
Avg. Drive Distance (m/sol)	Long	175	100	130	(*)
	Medium	125	70	100	115
	Short	50	35	40	50
Drive Sol Type usage	Long	50%	20%	30%	(*)
	Medium	20%	30%	40%	70%
	Short	30%	50%	30%	30%
Distance per sol (m) weighted average		127.5	58.5	91	95.5
Drive Sol count		47	150	80	124

33,870 = Total Path Distance (m)

401 = TOTAL TRAVERSE SOLS

* Long Drive may not possbile in late extended mission due to energy constraits

Traverse Duration Estimates

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- **Prime Mission** duration is 1.5 Mars Years
  - 33% (0.5 MY) mission margin is held for planning
    - **0.25 MY margin** is included in model for expected faults (i.e. “lost sols” such as command errors, comm outages, and other expected faults)
    - **0.25 MY margin** is held by Project and considered “unencumbered” (for major anomalies and unexpected faults)

- If the goal is to reach Midway by [Sept-2027], then total Extended Mission duration is 2.0 MY
  - Sept-20, 2027 equates to Sol 2341, or 3.5 MY after Mars2020 landing
  - Following 30% mission margin guideline, then …
    - **0.3 MY margin** is allocated for expected operations faults
    - **0.3 MY margin** is held as unencumered margin

1.4 MY for Extended Mission operations

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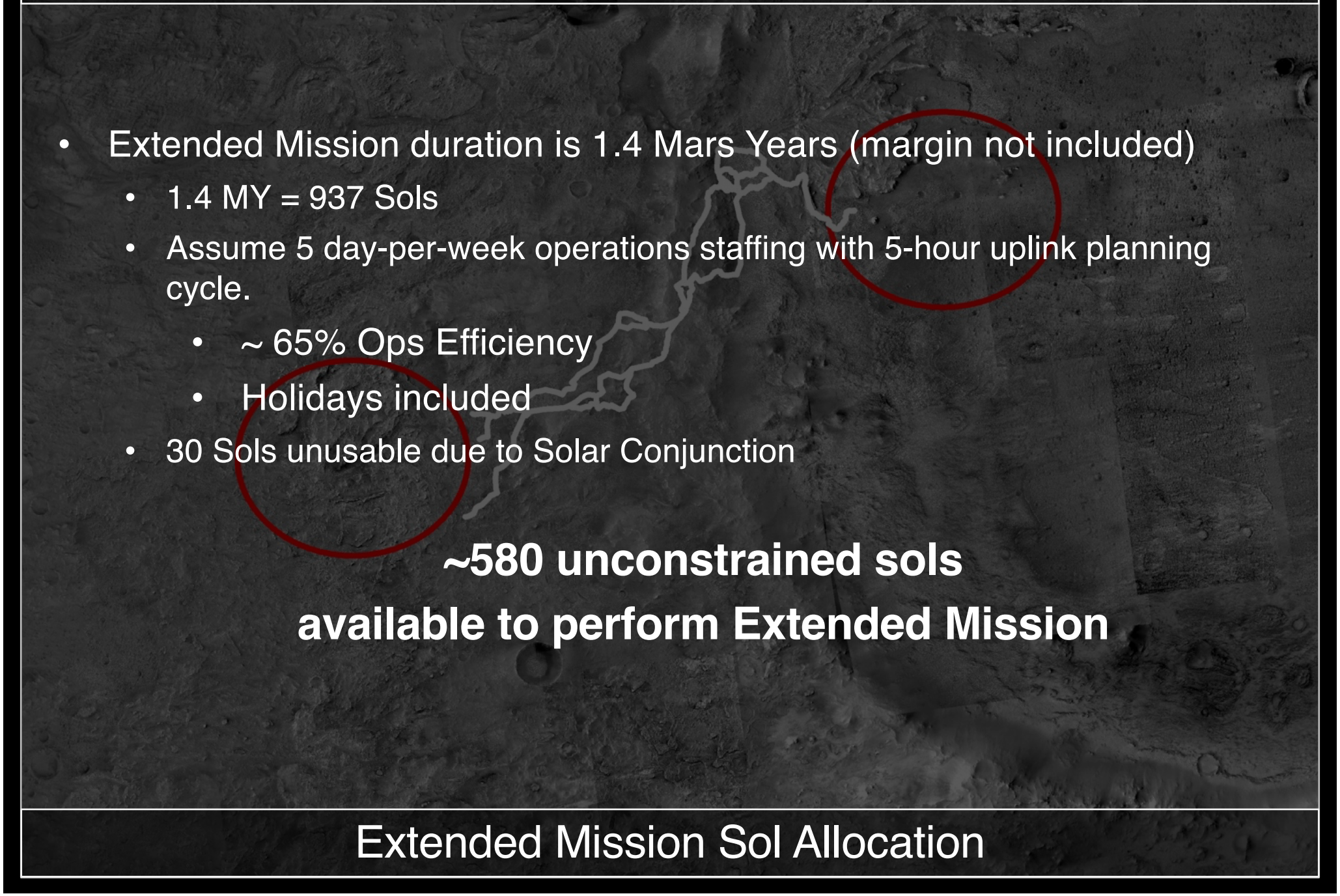

- Extended Mission duration is 1.4 Mars Years (margin not included)
  - 1.4 MY = 937 Sols
  - Assume 5 day-per-week operations staffing with 5-hour uplink planning cycle.
    - ~ 65% Ops Efficiency
    - Holidays included
  - 30 Sols unusable due to Solar Conjunction

~580 unconstrained sols
available to perform Extended Mission

Extended Mission Sol Allocation