The Mars 2020 Candidate Landing Sites: A Magnetic Field Perspective

Text

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PART 1 - Paleomagnetic studies on Mars

presented by Ben Weiss

PART 2 – Review of the remaining landing sites

presented by Anna Mittelholz

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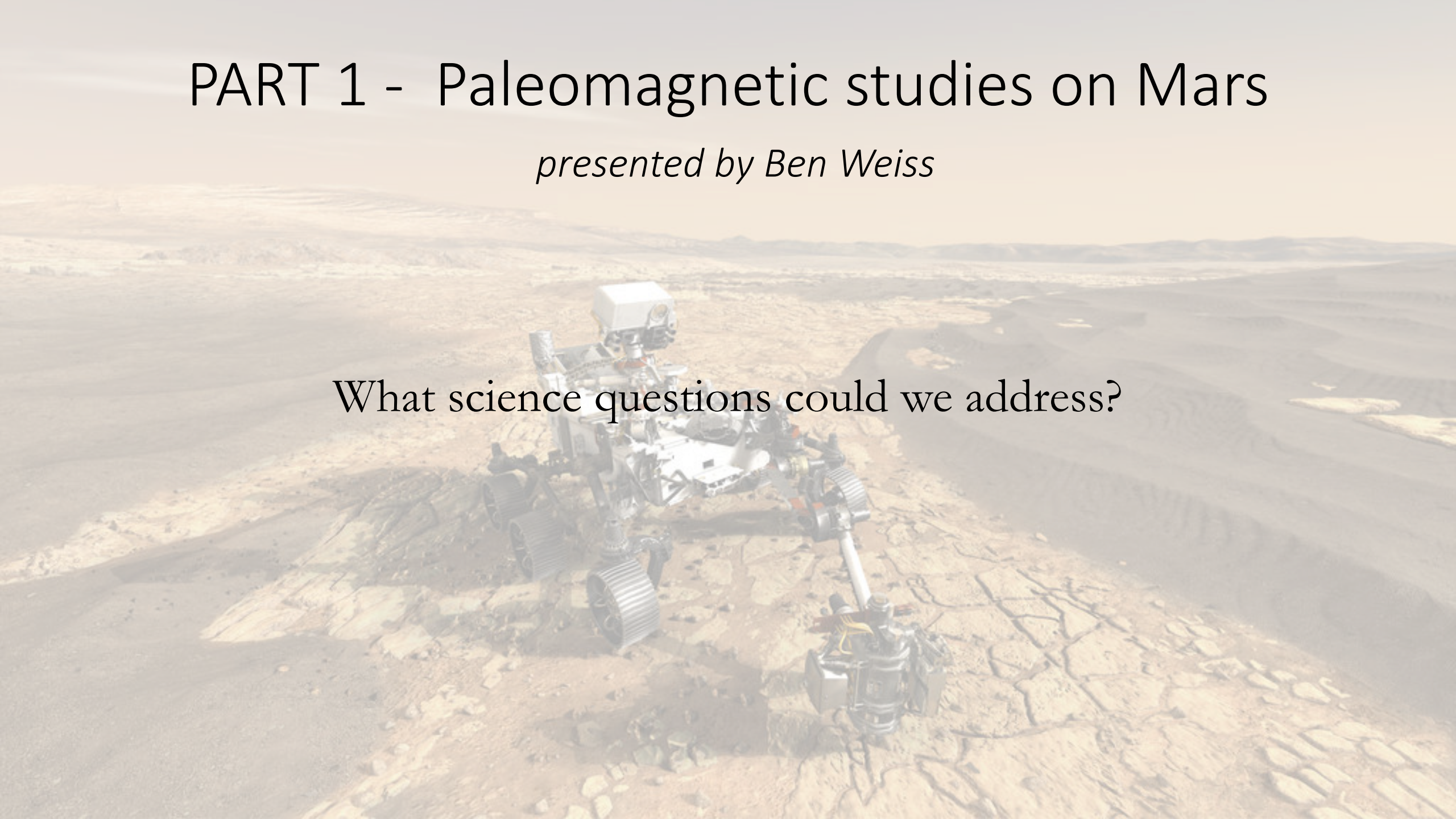


What science questions could we address?

What Science Questions Could We Address?

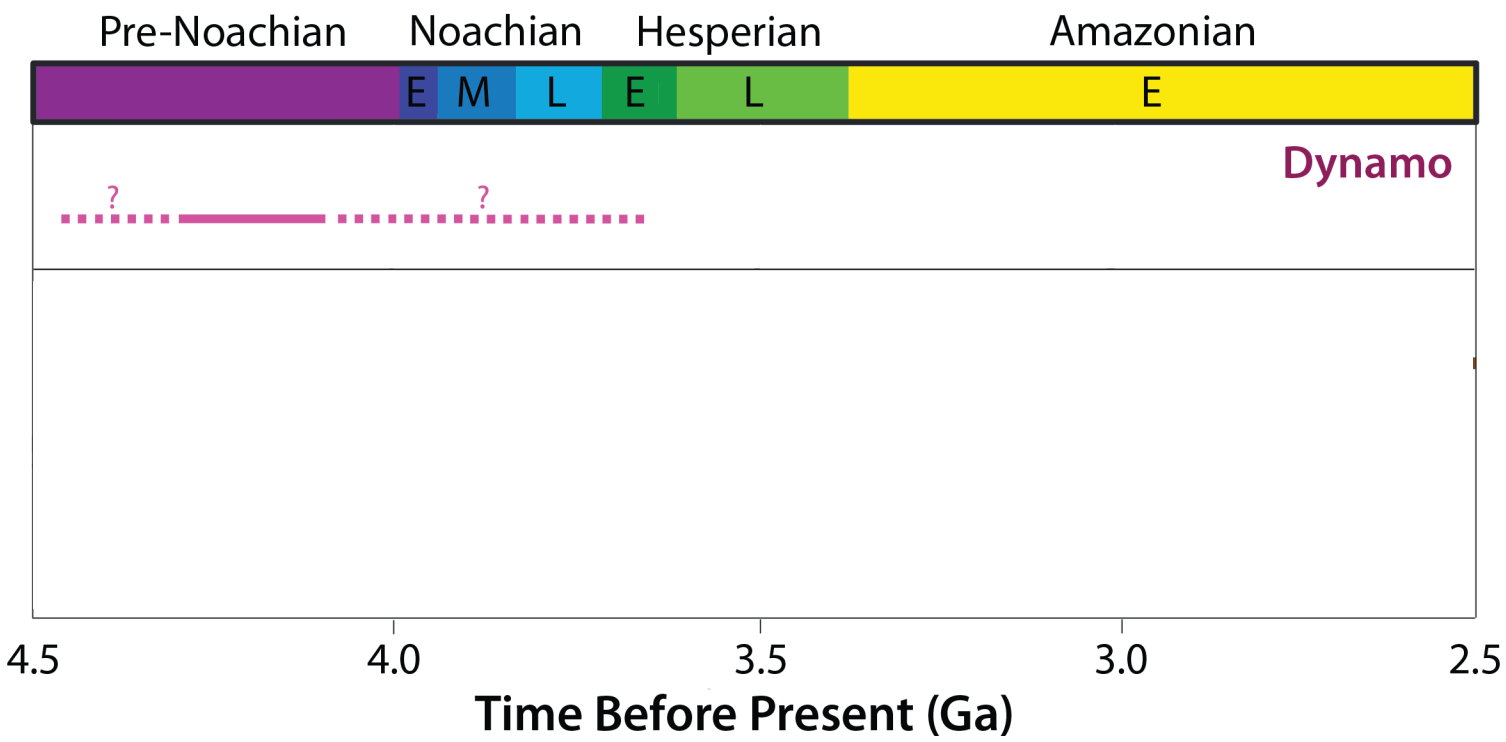
Community identified 6 key objectives for magnetic studies of returned samples (see supplementary slides). We will discuss 2 associated questions:

1) What is the **history** of the dynamo?

2) What are the main **magnetization carriers**?

Weiss et al. (2018) and iMOST (2018)

1)What was the **history** of the **dynamo**?



Modified from Ehlmann et al. (2016)

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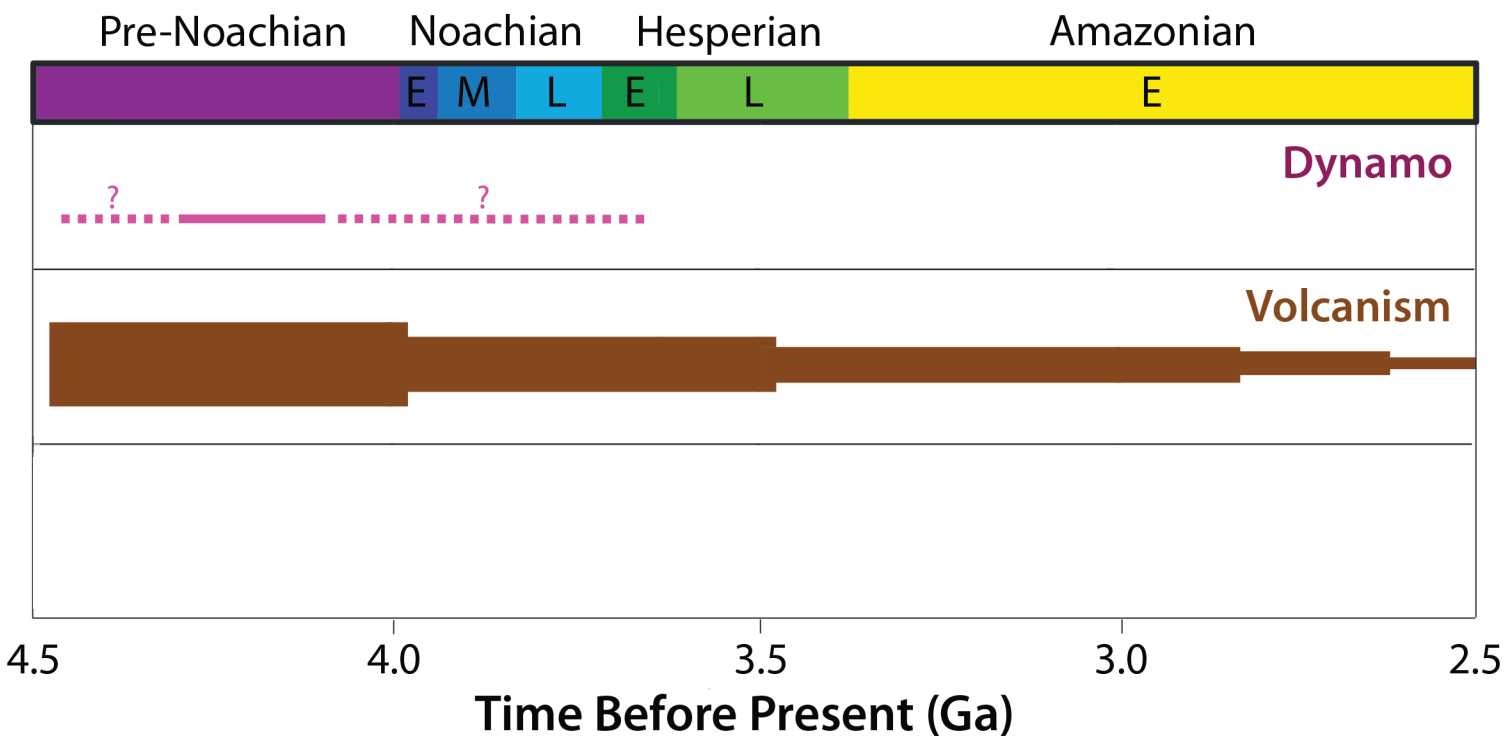

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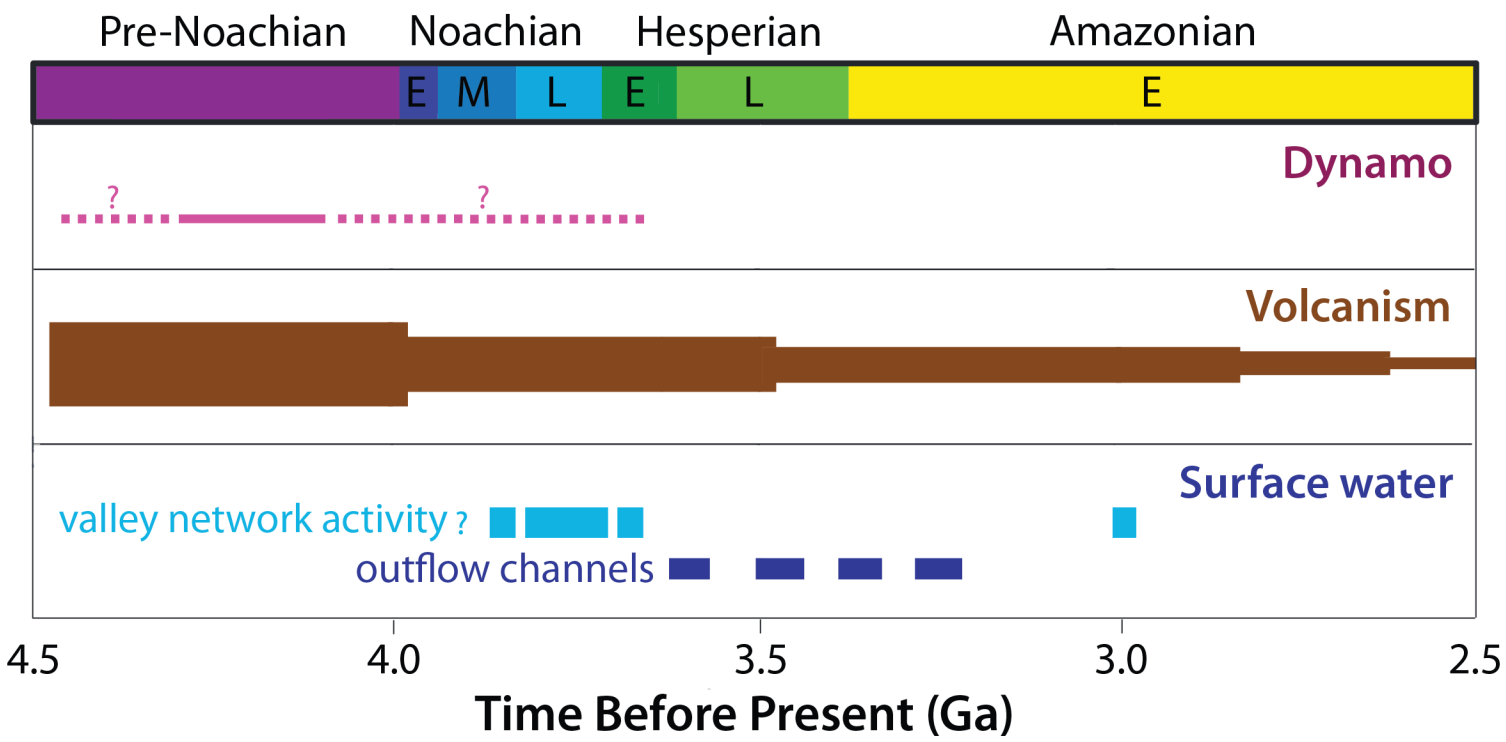

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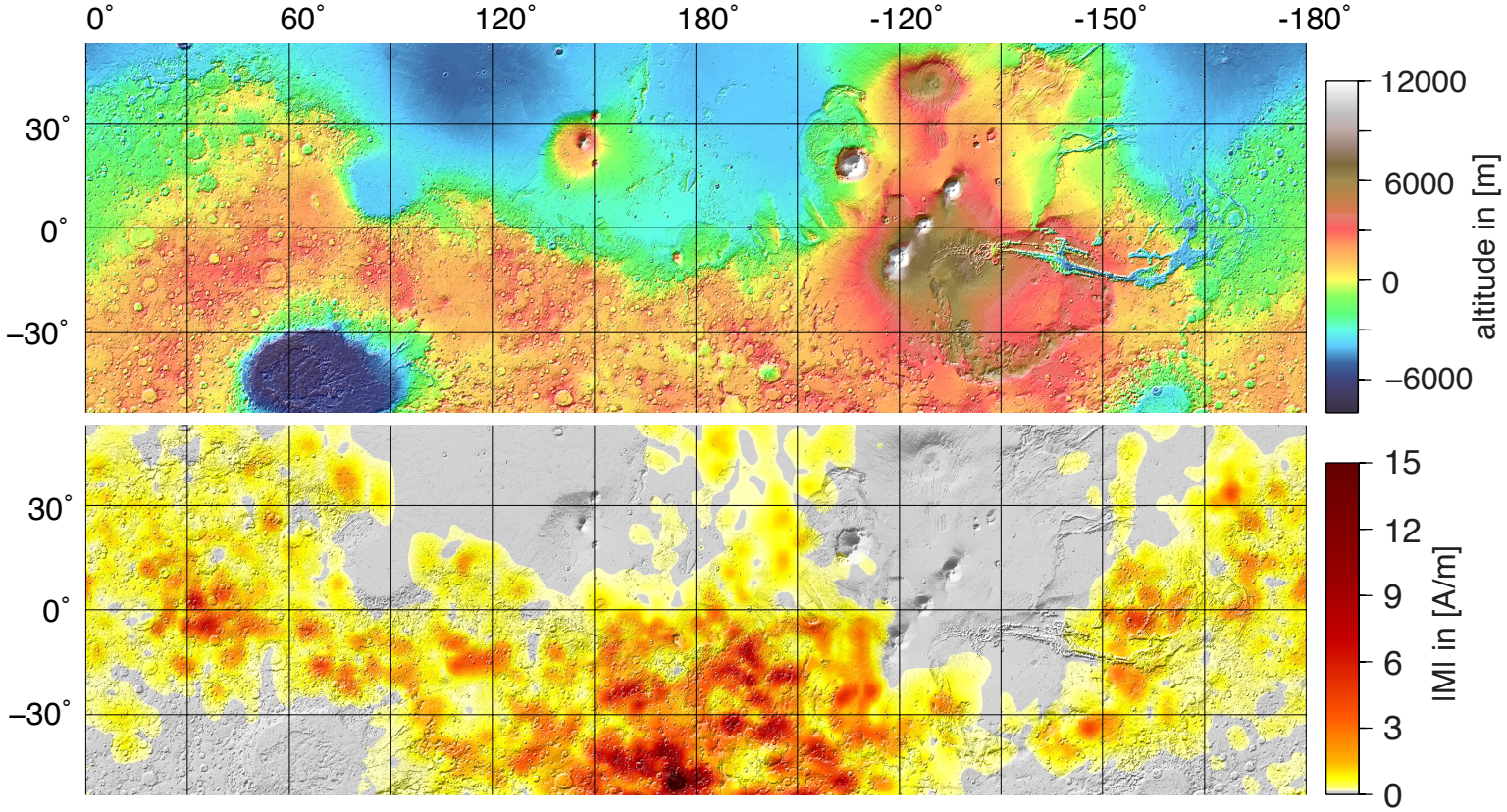
2) What are the main **magnetization carriers**?

Martian crustal anomalies >10× stronger than those on Earth

Martian Crustal Magnetization



Vervelidou et al. (2017)

2) What are the main **magnetization carriers**?

Widespread aqueous alteration of Martian crust?

Magnetite-rich Mudstones at Gale

Vaniman et al. (2014)

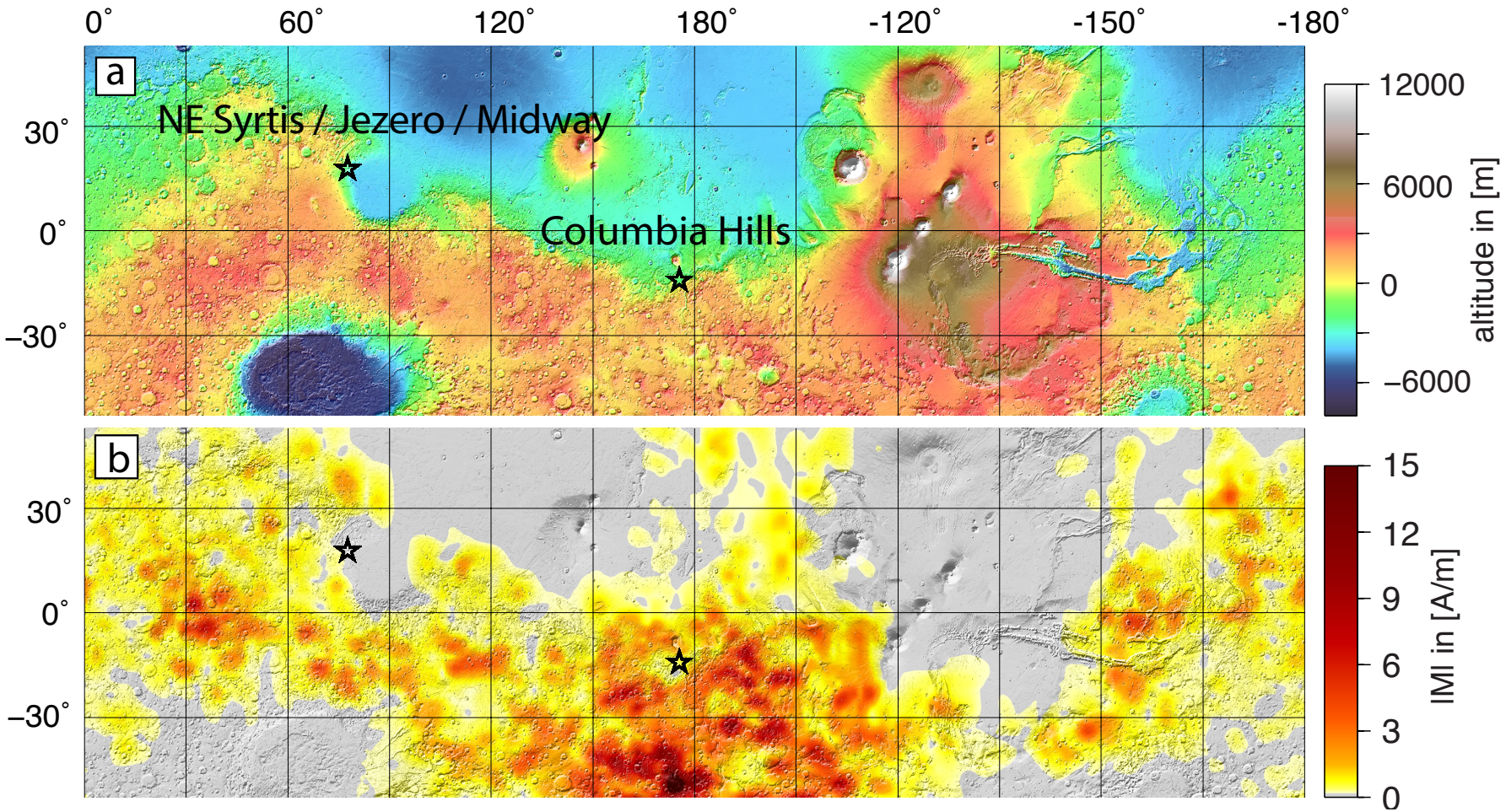
PART 2 – REVIEW OF THE REMAINING LANDING SITES

presented by Anna Mittelholz

- The magnetic field from a satellite data perspective

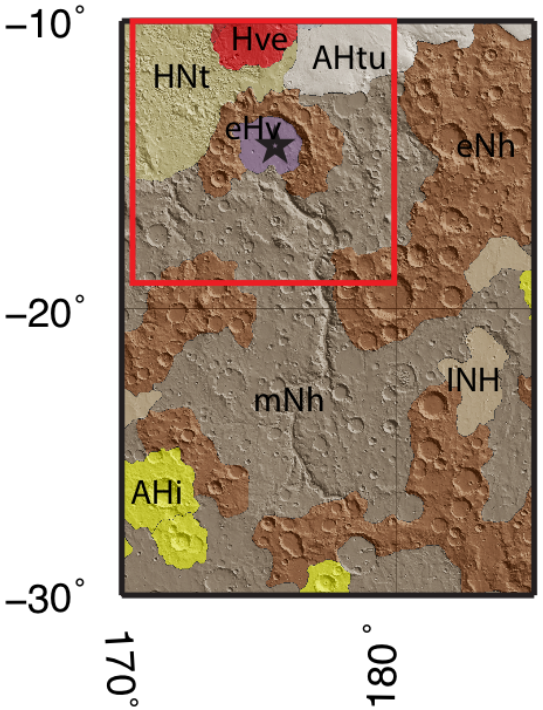
- Which magnetic science objectives can we achieve at each landing site?

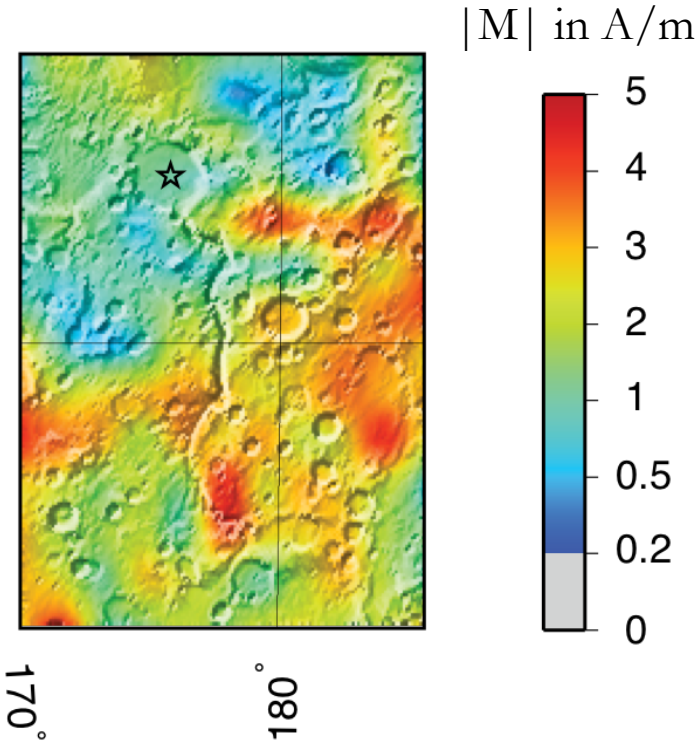
The magnetic field from a satellite data perspective



Vervelidou et al. (2017)

Local models of the crustal field from a satellite perspective

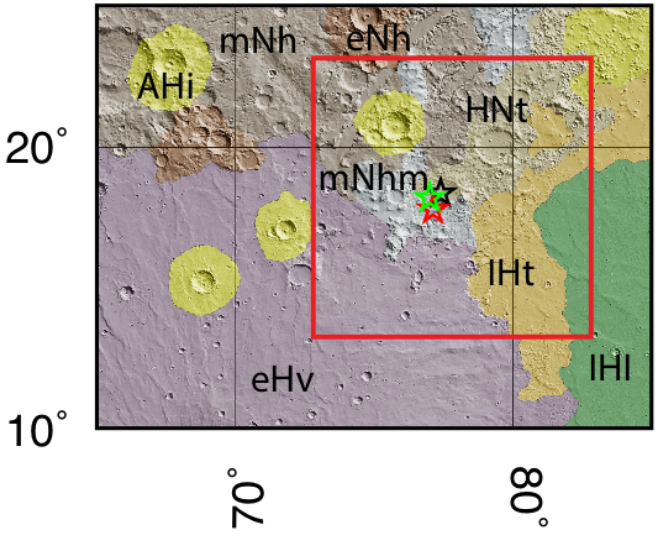


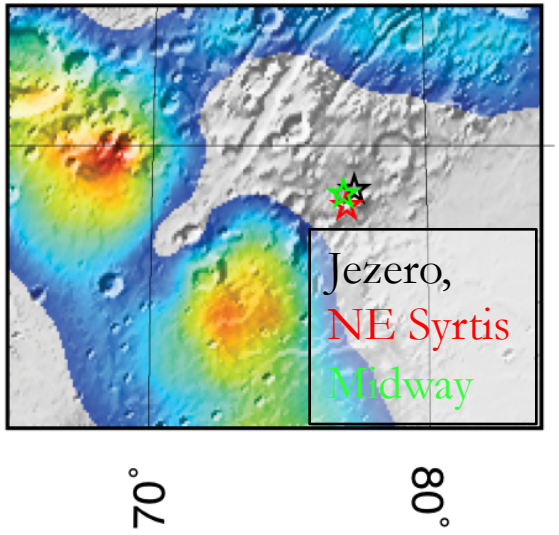


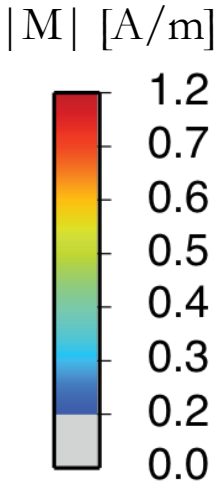
Columbia Hills

- Magnetization of moderate strength
- Mostly related to Noachian terrain
- However: Age of the surface material younger than probable shutdown of the dynamo field.

Local models of the crustal field from a satellite perspective







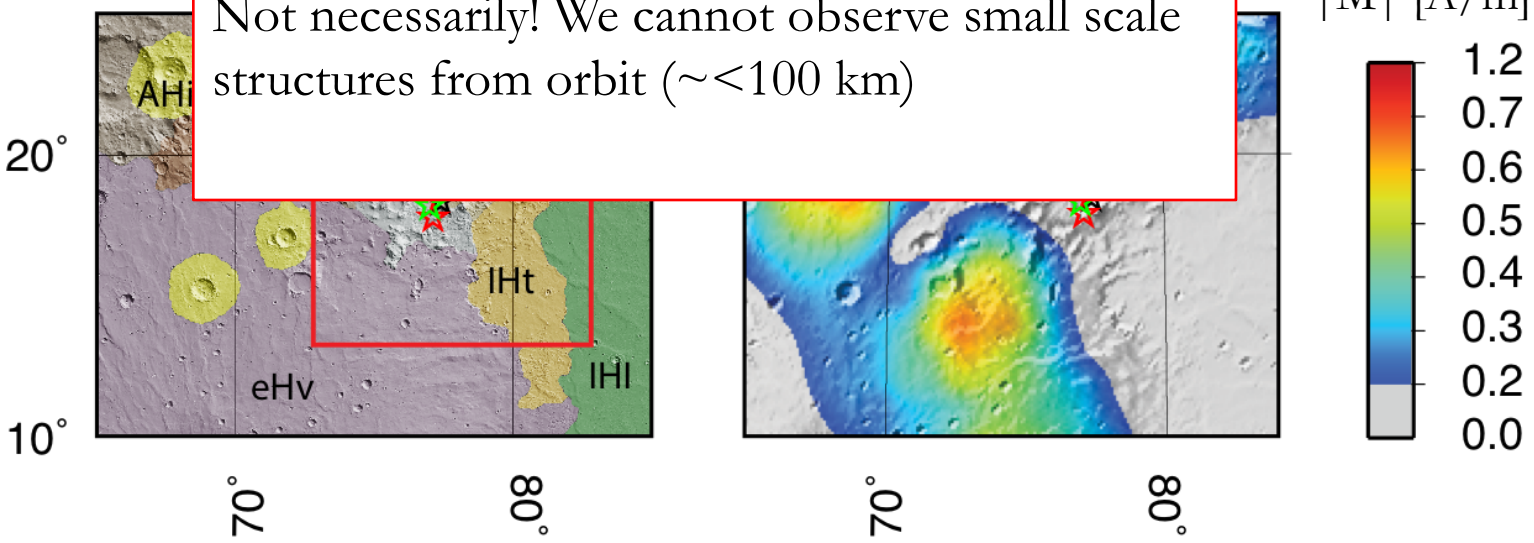
Jezero, NE Syrtis and Midway

- Magnetization very weak / not present
- Most (if at all) magnetization is related to Hesperian terrain
- Megabreccia outcrops have been identified in the NES and Midway landing ellipse

Local models of the crustal field from a satellite perspective

No magnetization at the surface?

Not necessarily! We cannot observe small scale structures from orbit (~<100 km)



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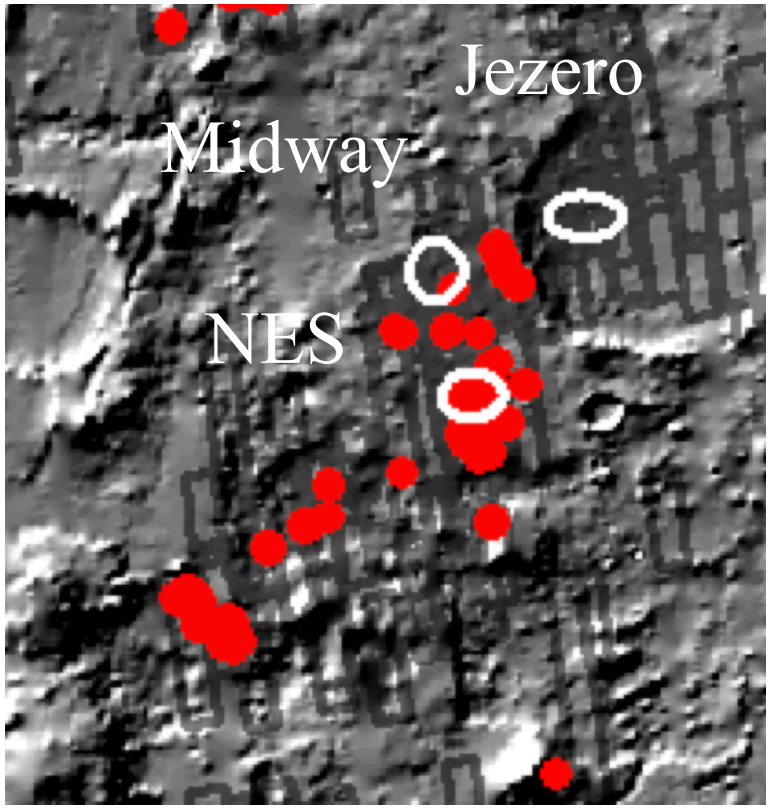
Which magnetic science objectives can we achieve at each landing site?

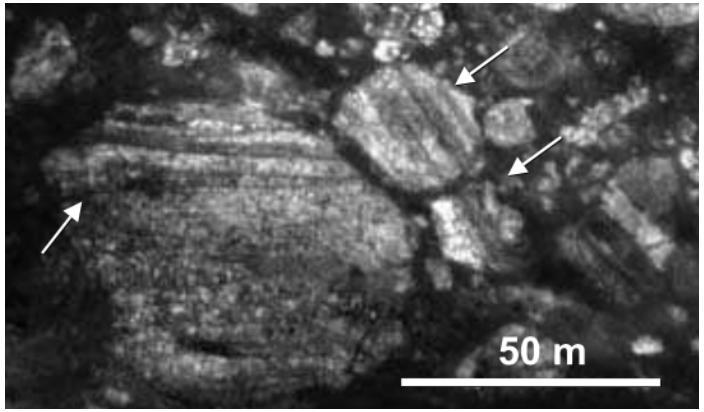
Locations of megablocks > 10 m



Provided by B. Ehlmann and E. Scheller

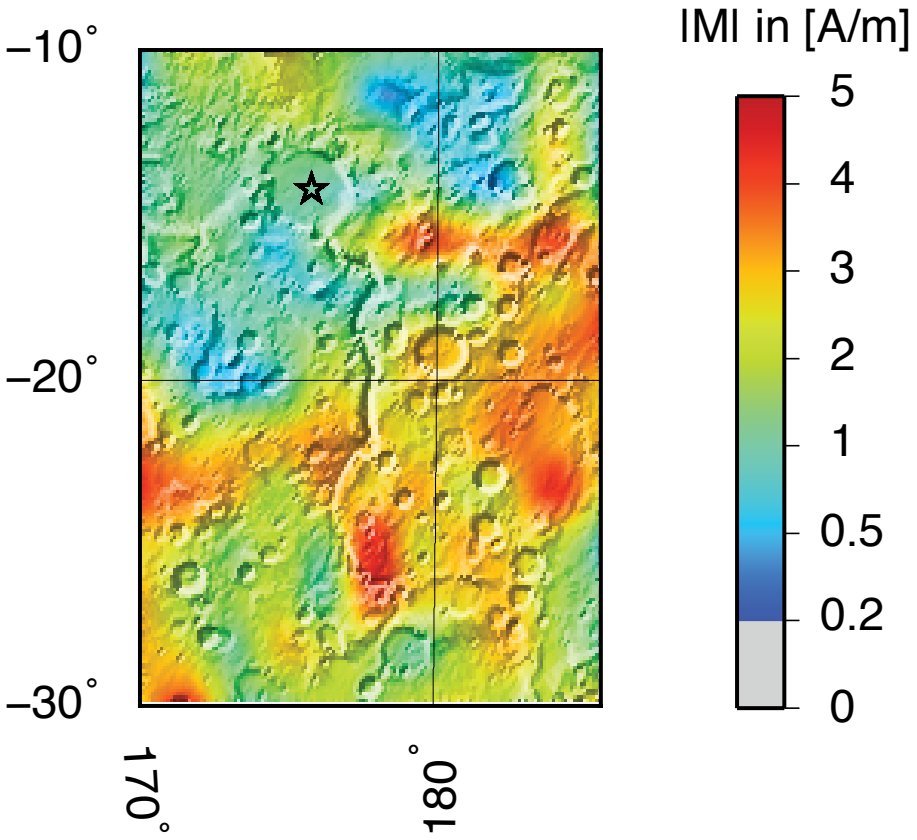
1) What was the **history** of the **dynamo**?

Requirement: Sites should contain rocks with a wide range of ages ideally extending back to at least the Early Noachian



Mustard et al. (2009)

Which magnetic science objectives can we achieve at each landing site?



2) What are the main **magnetization carriers**?

Requirement: Sites should offer a variety of mineralogies

Conclusion

- Mars 2020 offers the opportunity to acquire **samples** that record the **intensity and direction of the ancient martian magnetic field**.
- Laboratory magnetic measurements of returned samples can address questions about the **history of the martian dynamo, thermal evolution, and climate**.
- A **Jezero-Midway megamission** would combine access to Midway's ancient rocks and Jezero's relatively well-understood stratigraphy.
- We **recommend Northeast Syrtis or Midway** as preferred sites for magnetic investigations, followed by Columbia Hills and Jezero.

THANKS!

Additional Slides

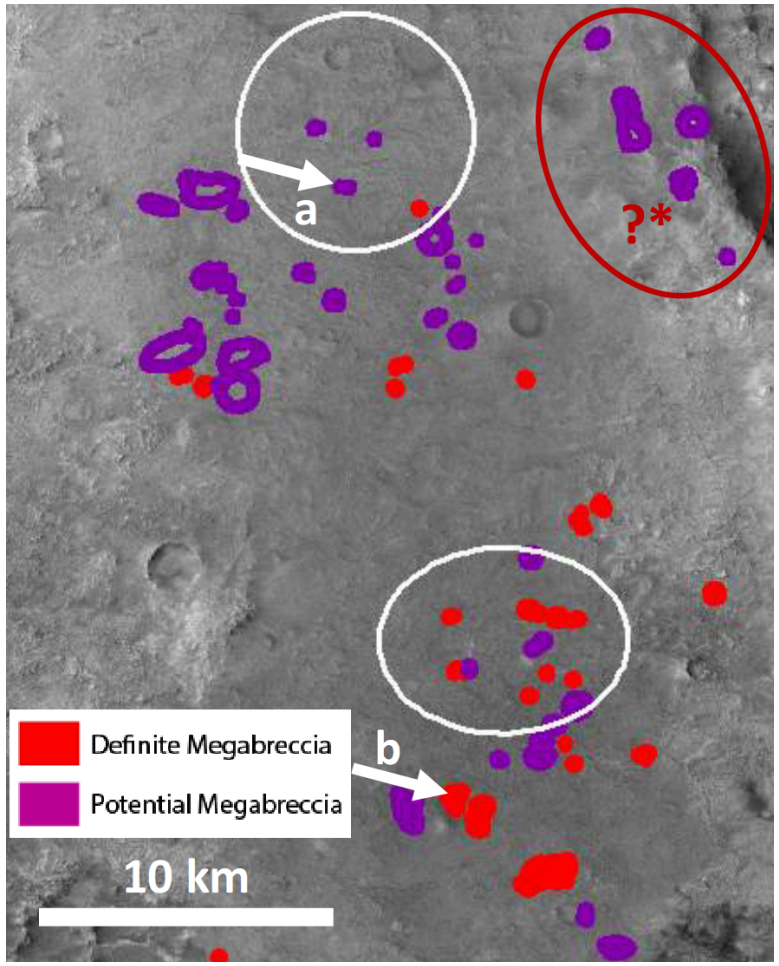
Landing Site Rankings

Science Objectives	Site Requirements	NES	CH	JE	Midway
1. Determine the intensity of the Martian dynamo.	Samples old enough (pre-Noachian and Early Noachian) to have likely been magnetized in ancient dynamo magnetic field.	***	**	**	***
2. Characterize the dynamo reversal frequency and conduct magnetostratigraphy.	Samples should span a dateable large time interval, ~>1 Ma, during Early Noachian; orientation should be known to within 30°.	***	**	**	***
3. Constrain the effects of (i) heating and (ii) aqueous alteration on the samples.	Variety of samples: (i) heated samples and (ii) evidence of water at the surface.	**	***	**	**
4. Test the hypotheses that Mars experienced plate tectonics and/or true polar wander and constrain the tectonic and deformational history of the landing site.	Parent rock of sample should be in-place bedrock or at least contain paleohorizontal indicators such as bedding planes or stratified grain size sorting.	***	**	*	***
5. Determine the major mineral carriers of Martian crustal magnetization.	Site should offer a variety of mineralogies.	**	***	**	**
6. Constrain sediment sourcing, fluid flow, and the depositional environment using environmental magnetism studies.	Site should offer environments where evidence for sediment deposition and fluid flow exists.	**	***	**	**

From Mittelholz et al. , 2018

https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2018EA000420

Megabreccia at Northeast Syrtis and Midway



Scheller and Ehlmann (this meeting)