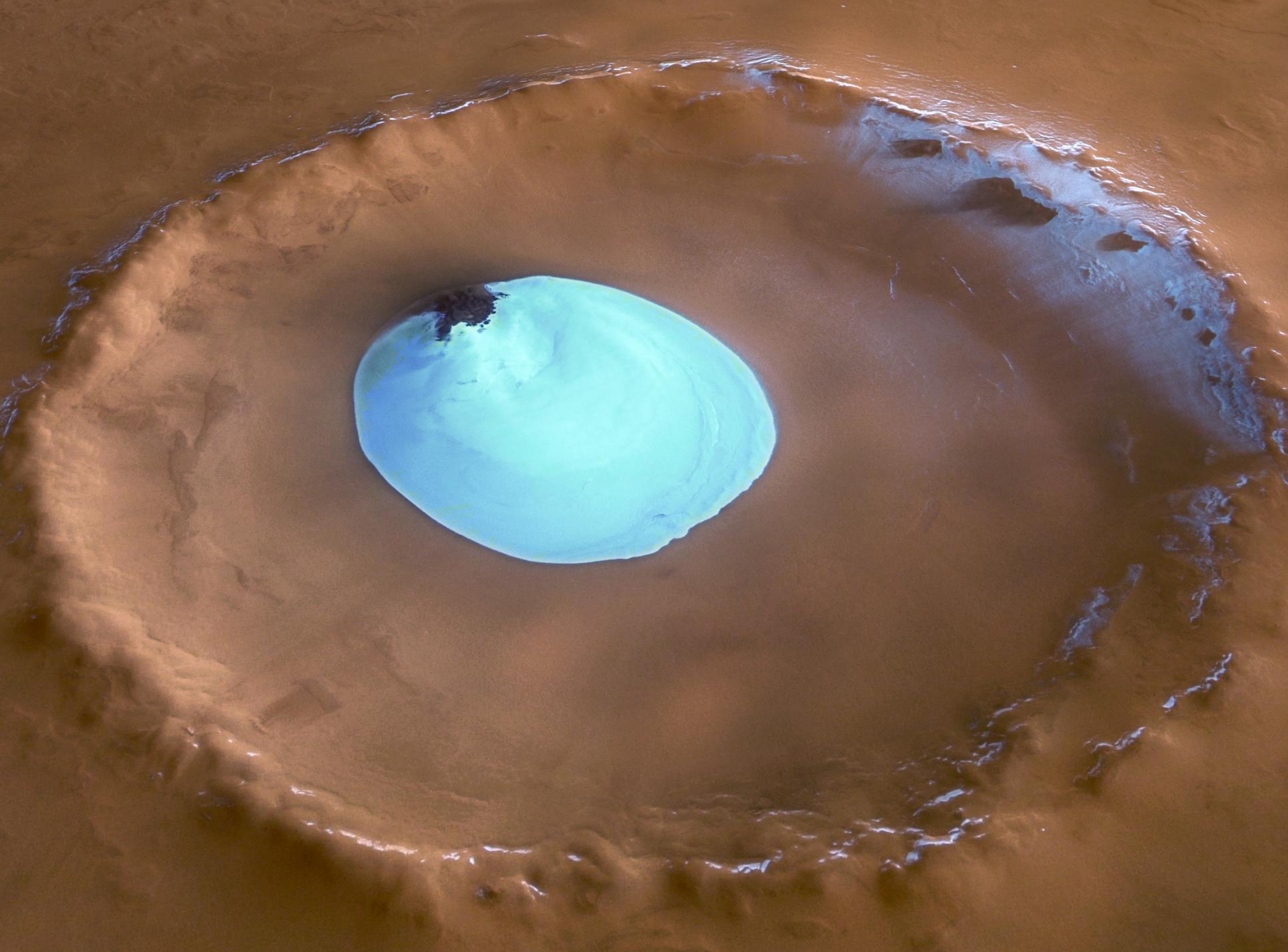
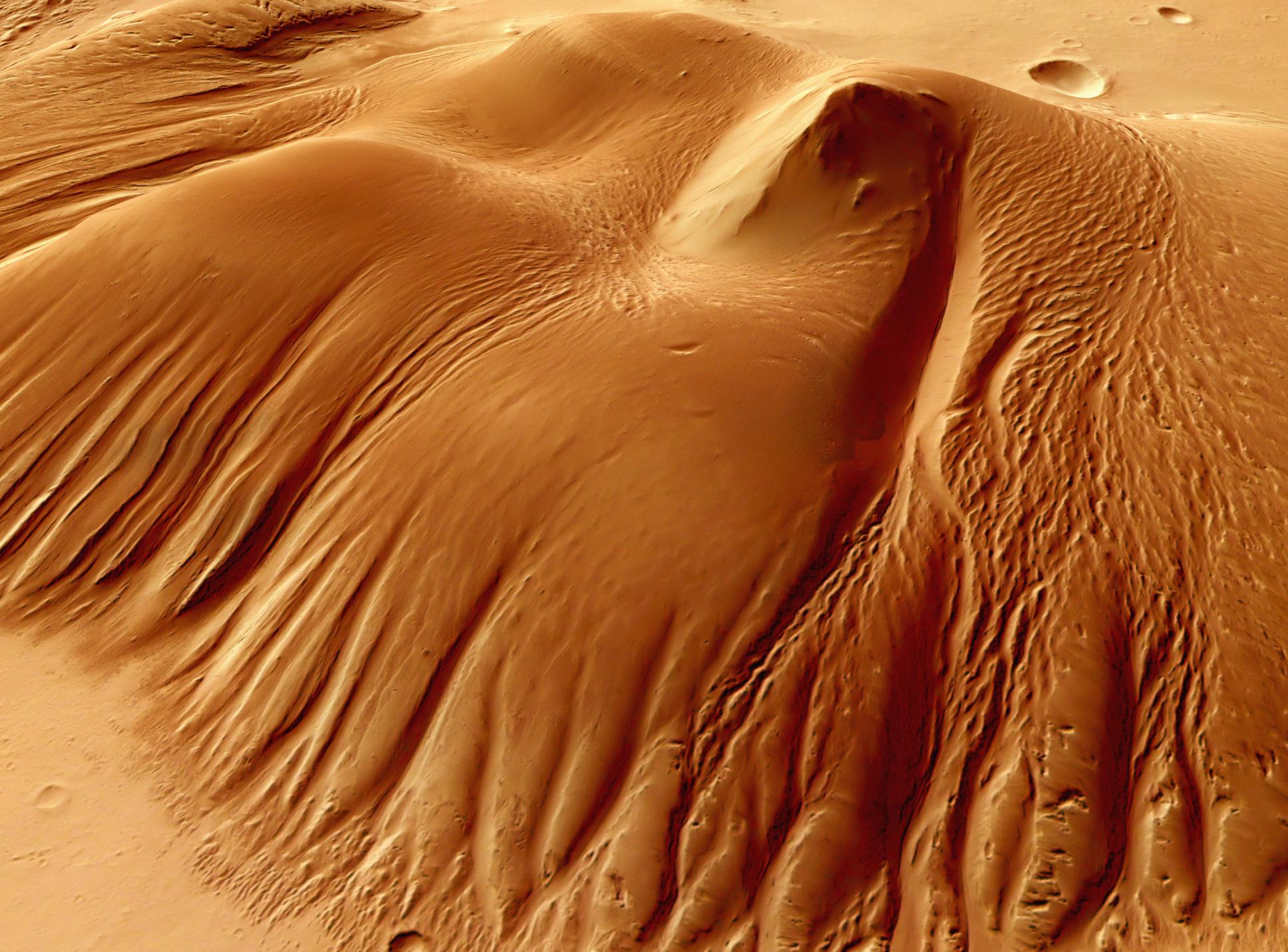




Mars Landing Site Selection: A Crew Perspective







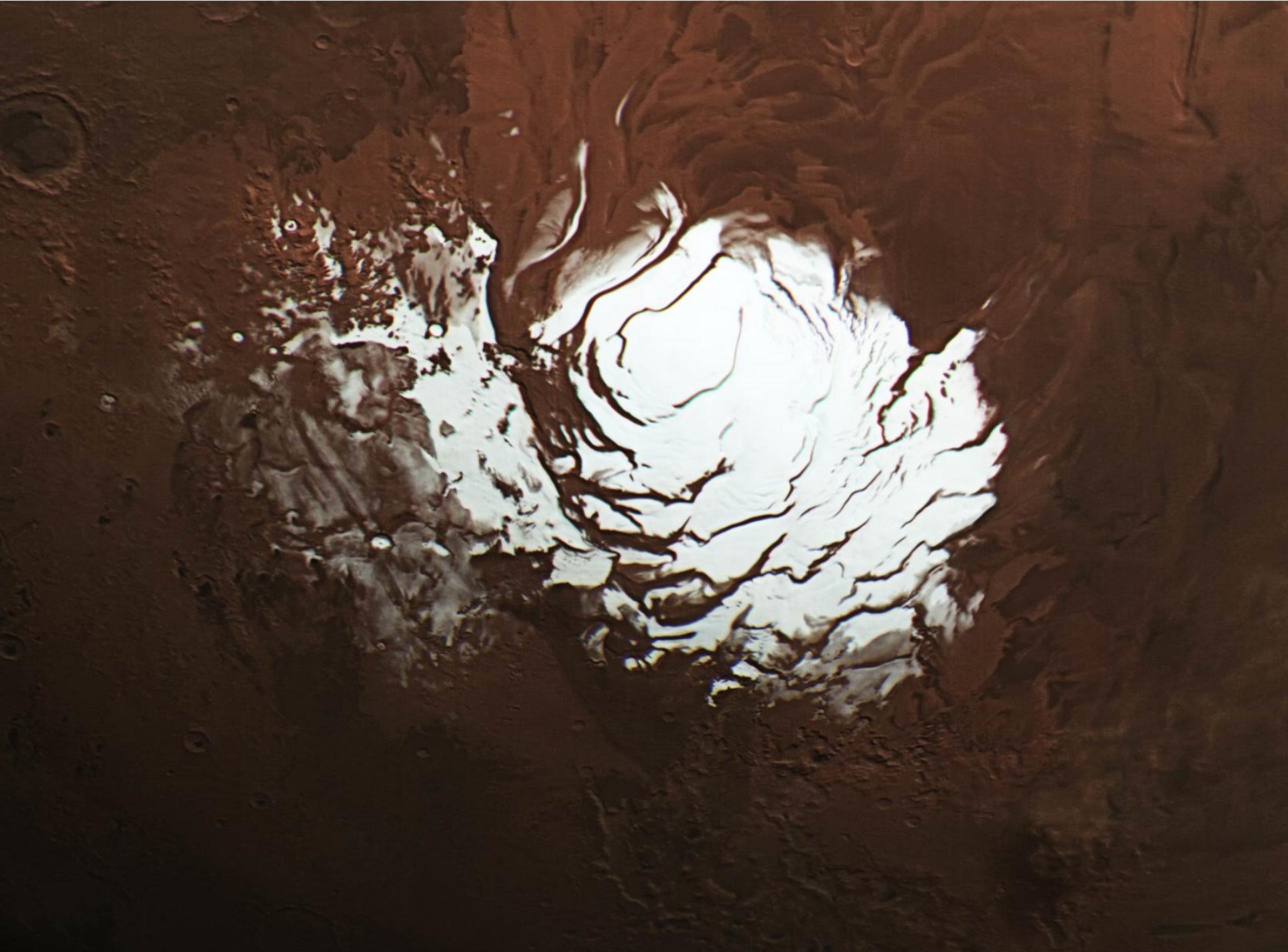
It's all good.

(We don't care.)

Safety & Operability

Safety

(will it kill us?)



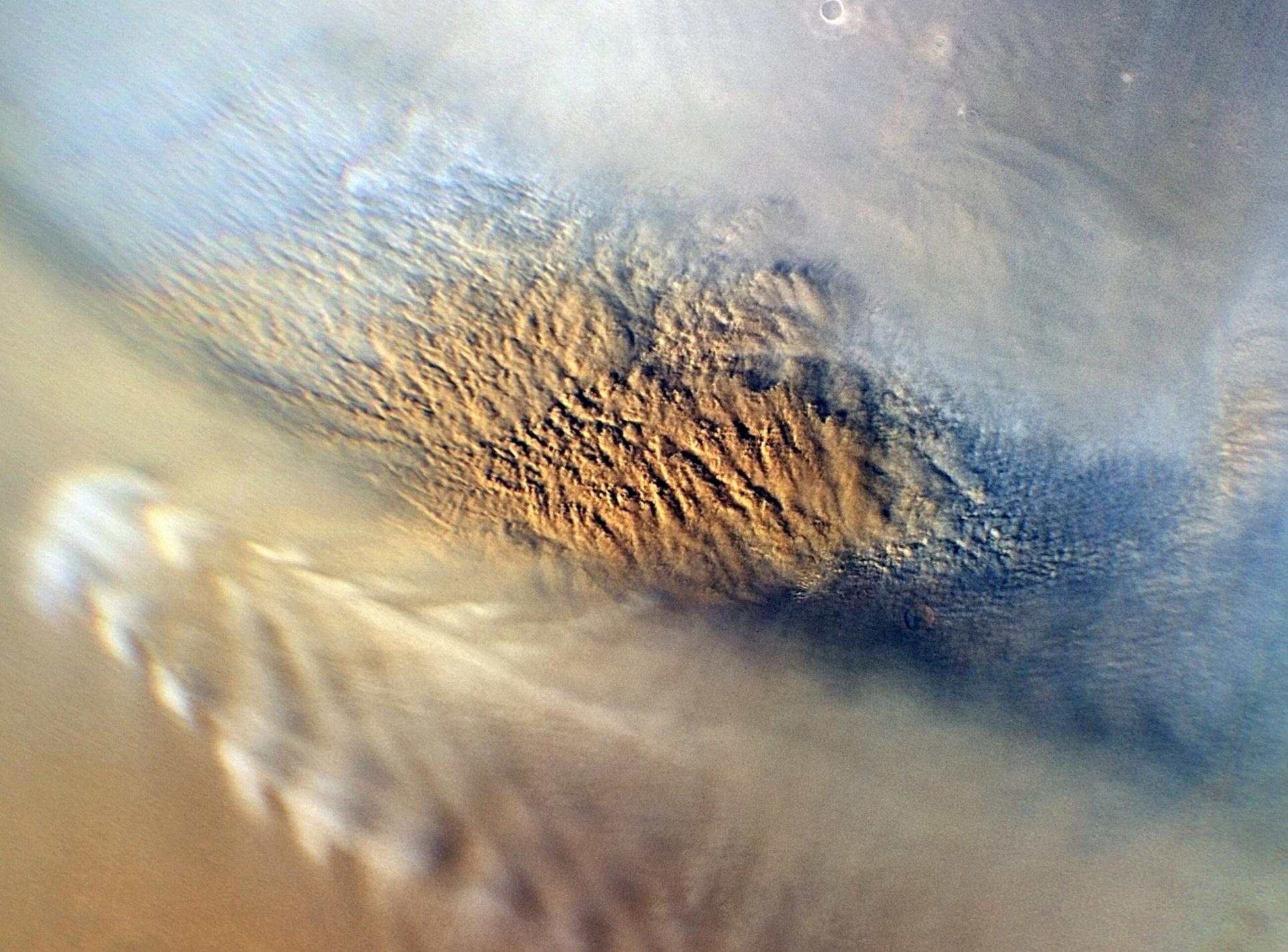
High Latitude

- Restricts access to orbiting assets.
(inclinations less than latitude are unreachable)
- Reduces ascent performance margin.
(less assist from planetary rotation)
- May constrain emergency departure opportunities.
- Has cold temperatures, which are bad for machines.
(mechanisms have cold-related problems in the Earth's polar regions...and the poles of Mars are even colder!)



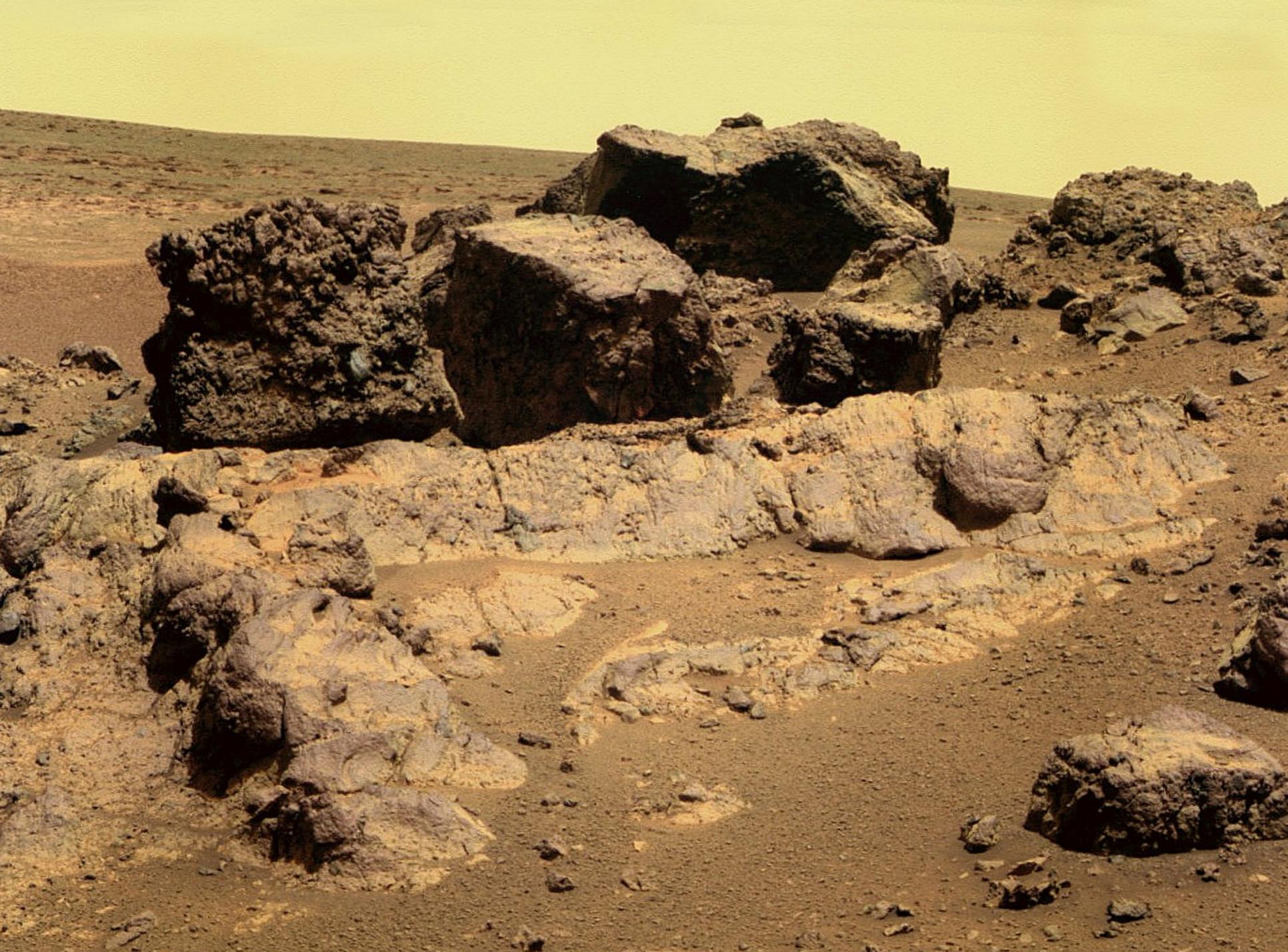
High Latitude bonus: Bad Lighting

- Little or no daylight in winter.
(bad for landing and for driving rovers)
- Low sun angles, long shadows, and glare, even in summer.
(bad for landing and driving)



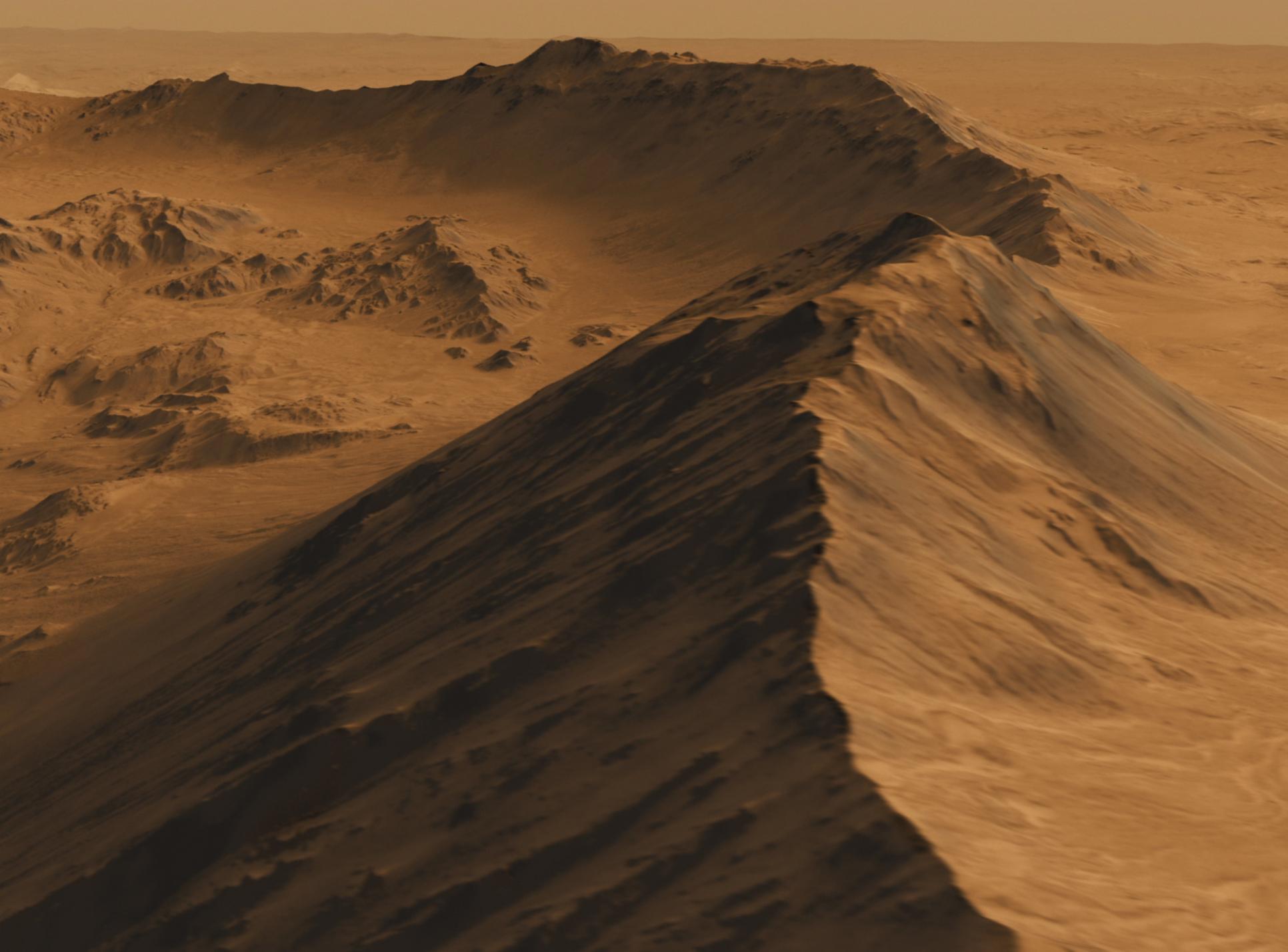
Dust Abundance and Frequency of Storms

- Dust storms are not as bad as shown in The Martian!
- But dust is bad for landing and airlocks and suits and mechanisms and solar panels and...



Boulders

- Boulders are bad for landing and for driving rovers.



Steep Slopes

- Steep slopes are bad for landing and for driving rovers.



High Altitude

- Low air density has pros for landing
(reduces jet confinement and dust entrainment)
- Low air density also has cons
(complicates heat rejection and aerodynamic decelerators)

Safety Summary

Landing and working on Mars will be safer if the landing site:

- is not at high latitude,
- is not very dusty or prone to dust storms,
- is free from large boulders,
- and does not have steep slopes.

A high-altitude landing site may help or harm us. Stay tuned.

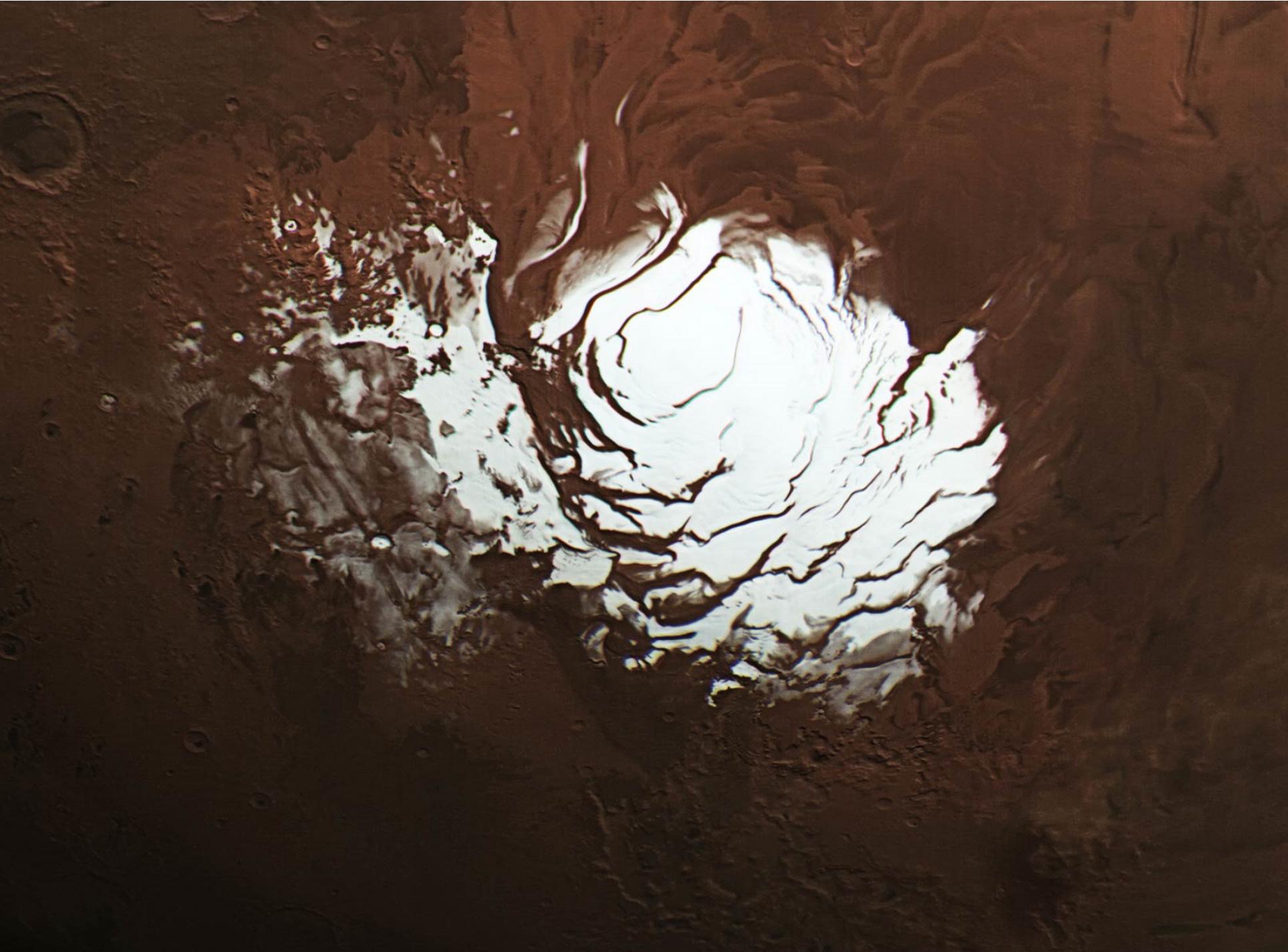
Operability

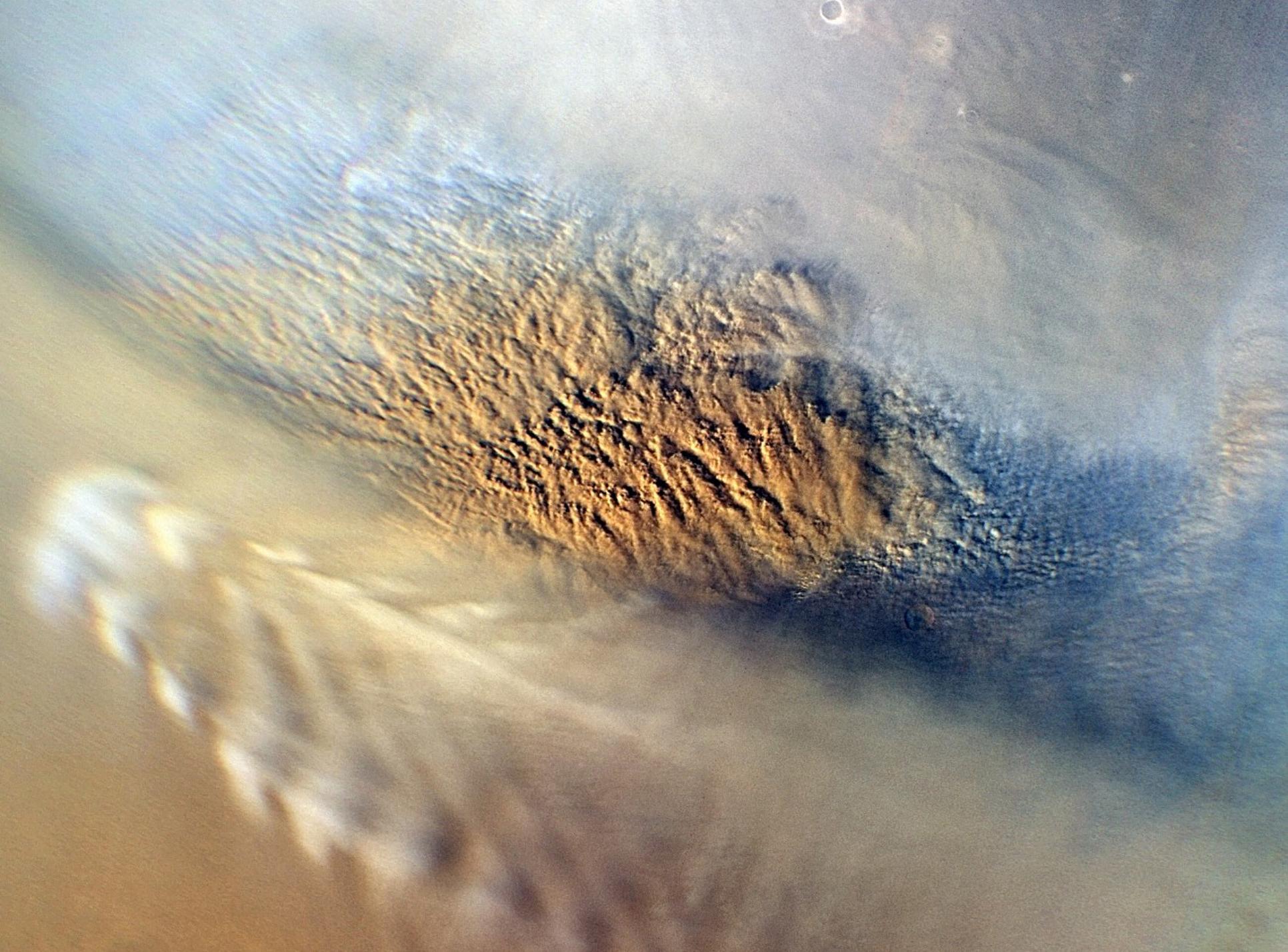
(can we work there?)

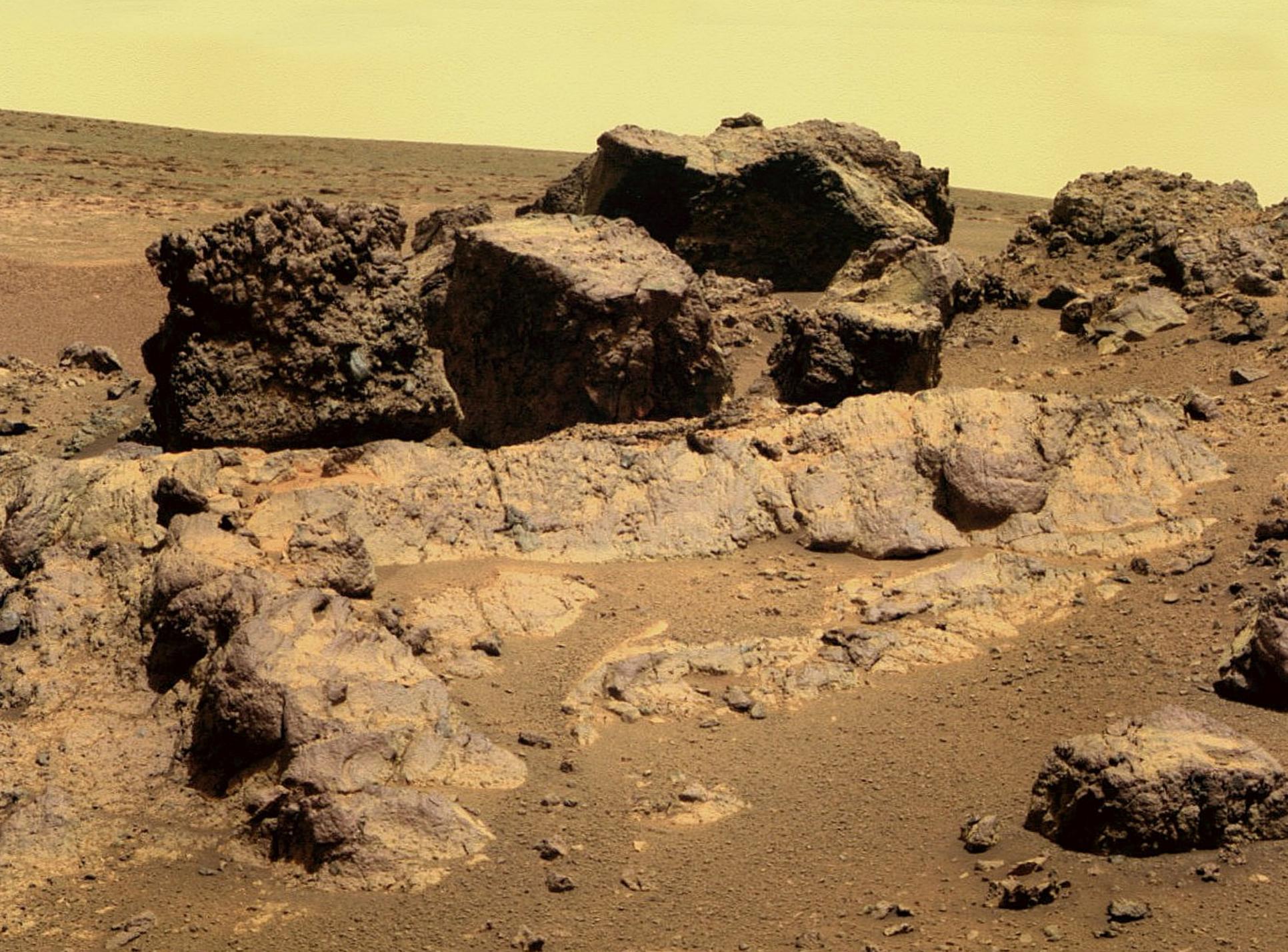
Operational Constraints

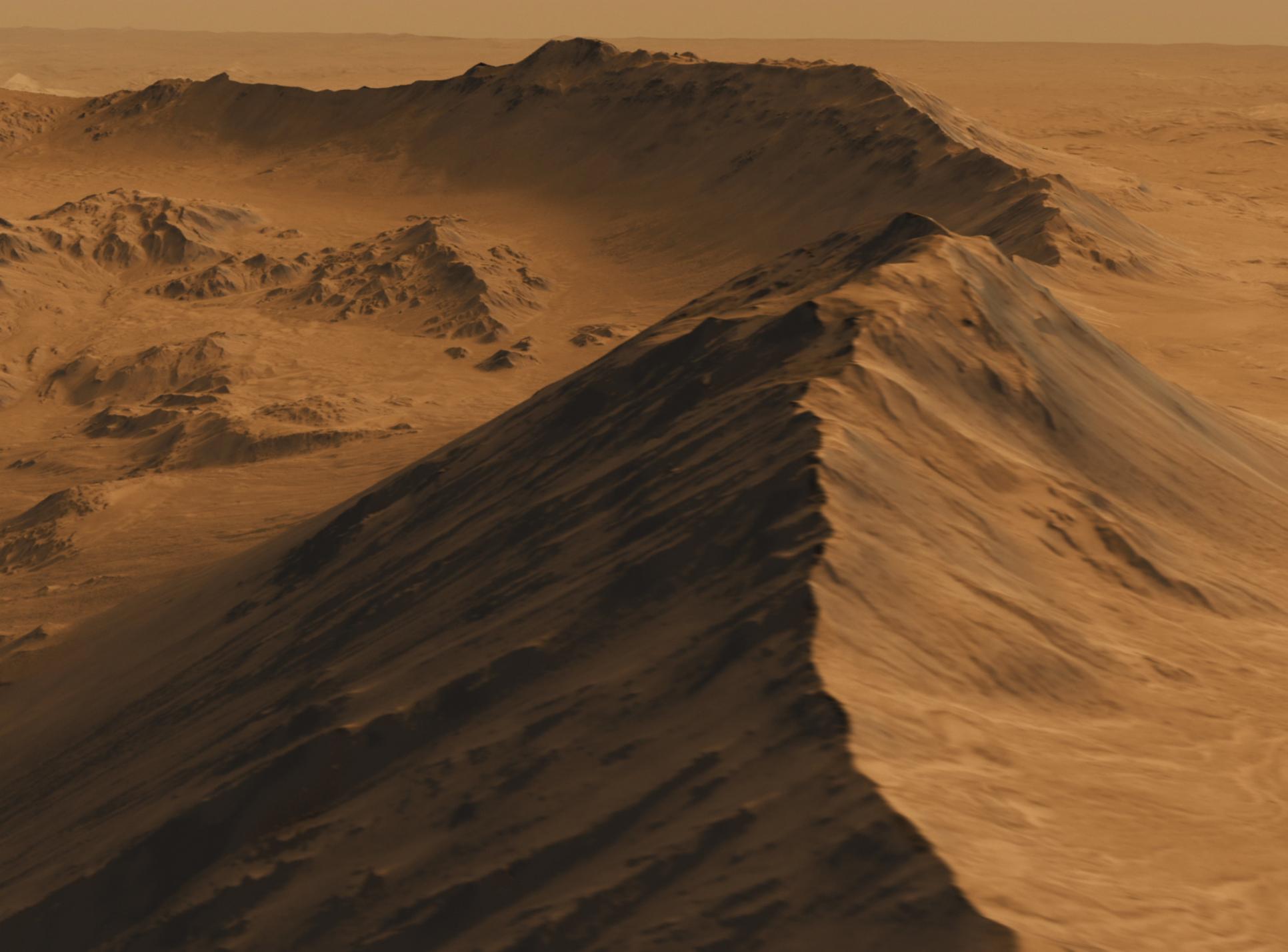
Extra safety precautions--and extra care of systems--eat into the time available for work.

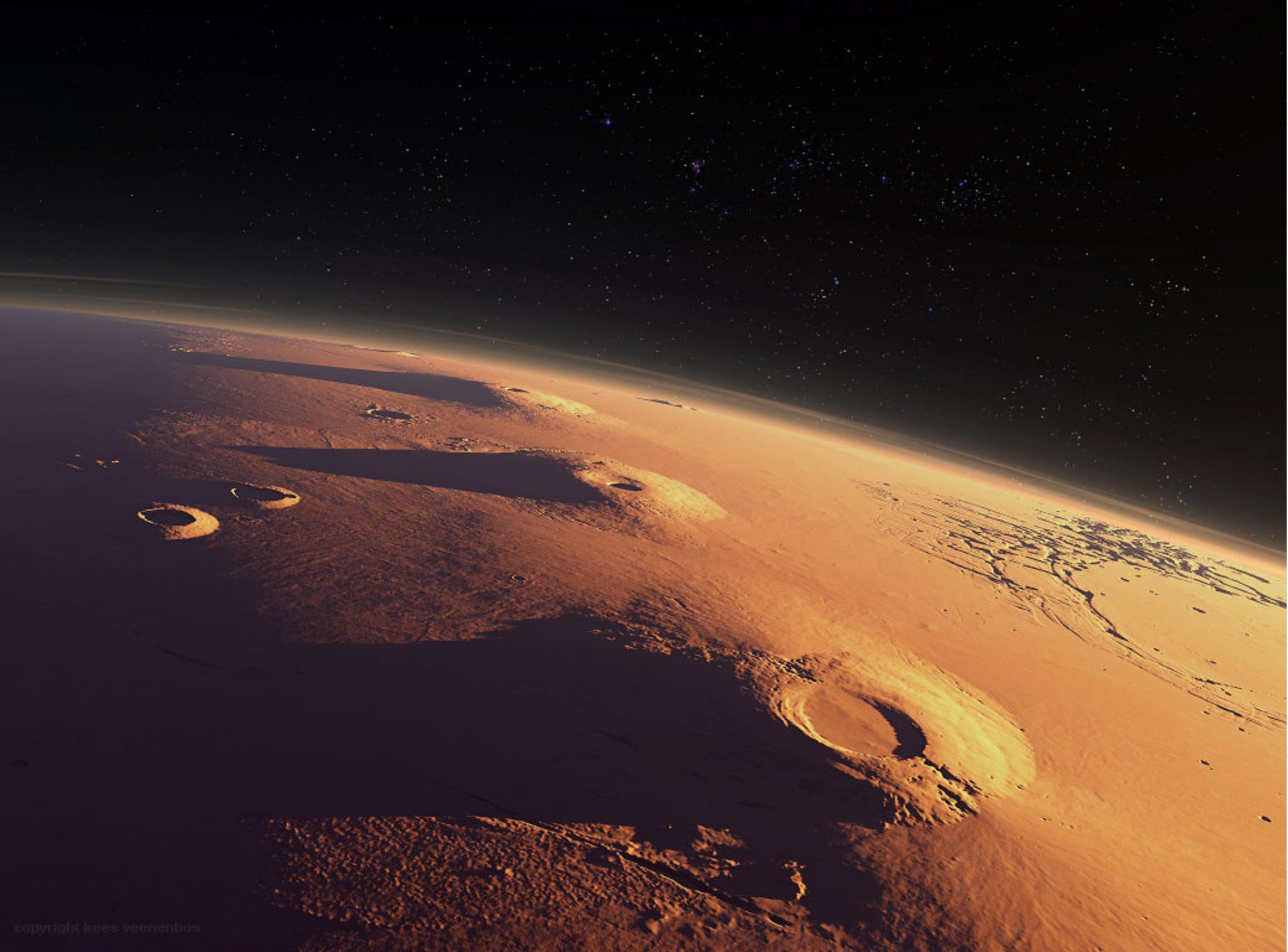
The safer and more temperate the landing site, the more work we can do there.











Operability Summary

Polar latitudes, abundant dust, large boulders, and steep slopes are good things to avoid. High altitudes may or may not make a difference.

Another Operational Consideration:



Another Operational Consideration: Biologically Interesting Sites

All suits and habitats leak, possibly venting bacteria and viruses (forward contamination).

No technique for cleaning suits and tools that have been outside is guaranteed to remove all bacteria and viruses (back contamination).

Even the most expensive equipment and time-consuming protocols cannot eliminate these problems. But they can easily eliminate all available budget and crew time.

Another Operational Consideration: Biologically Interesting Sites

We have a hard decision to make:

1. Go to a biologically interesting site, get a gold star for planetary protection, and possibly accomplish little or no work.
2. Go to a biologically interesting site, cut corners on planetary protection, and possibly irrevocably contaminate Mars or Earth.
3. Go to a biologically boring site...so, why bother going at all?

Reminder:

(human limitations)

Human Limitations

Human space flight is interesting because it has humans in it.

In space, as in other hostile environments, just keeping humans alive takes considerable time and effort.





Human Limitations

ISS and ANSMET

Sleep	8.5 hours/day
Meals and Hygiene	4.5
Team (MCC, Crew) Coordination	1.0
Exercise	1.5 ?
<u>Off-Duty</u>	<u>1.5</u>
Total	17.0 hours/day
Work	7.0 hours/day
of which, System Operation	2.0 ?
Which leaves...	~5 hours/day for geology, biology, and exploration

Summary and Conclusion (1)



- The crew's stake in landing site selection is limited to safety and operability considerations.
- Sites at low to moderate latitude that are relatively free of dust, boulders, and steep slopes will improve both safety and operability.
- The jury is still out on altitude.

Summary and Conclusion (2)



- **Biologically interesting sites will take special attention: planetary protection conflicts with operational efficiency.**
- **Expect no more than 5 hours a day of real exploration and science.**