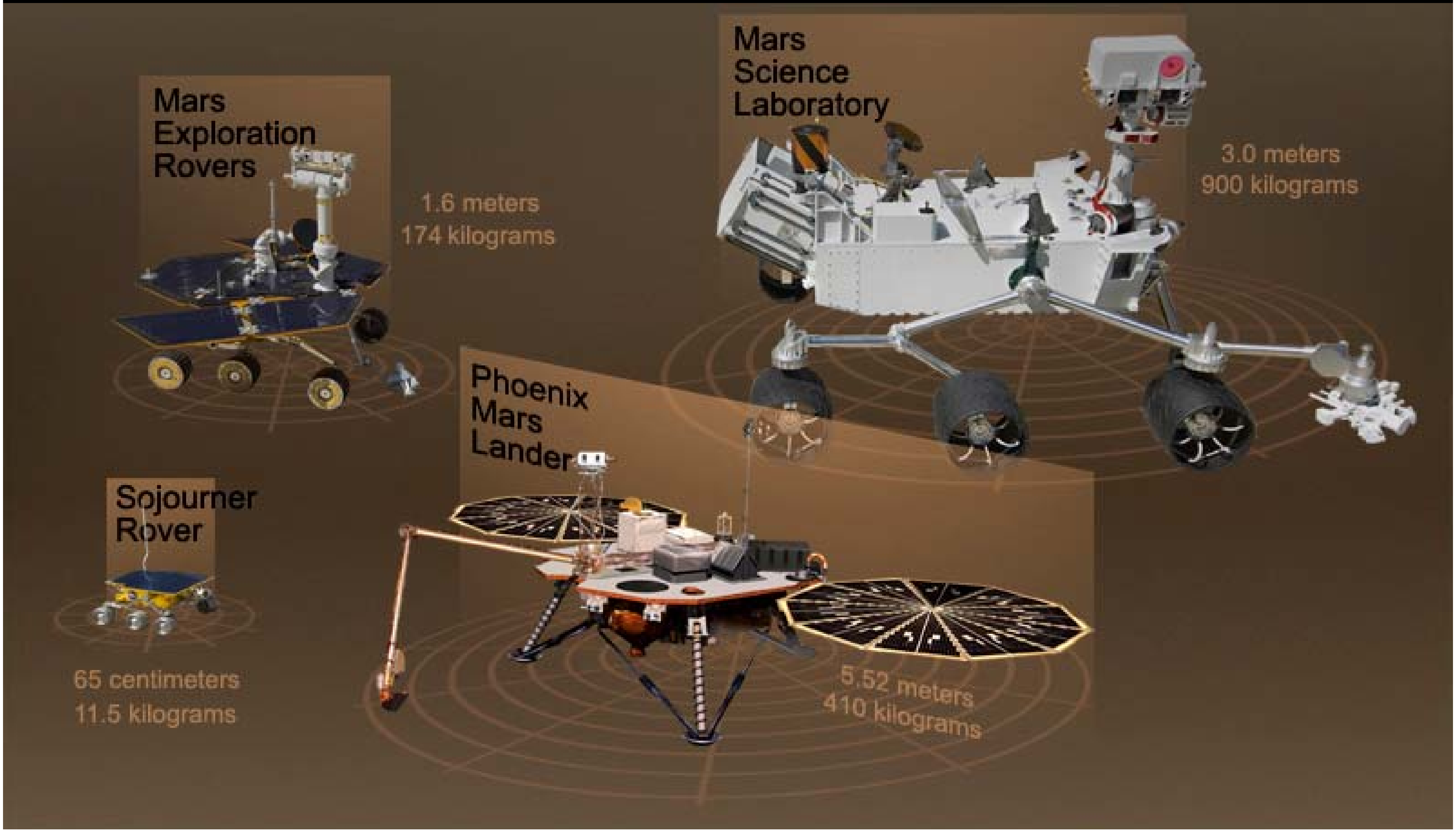
Lander Mission Science

Hap McSween, *pinch hitting for Ray Arvidson, pitching for Steve Squyres*



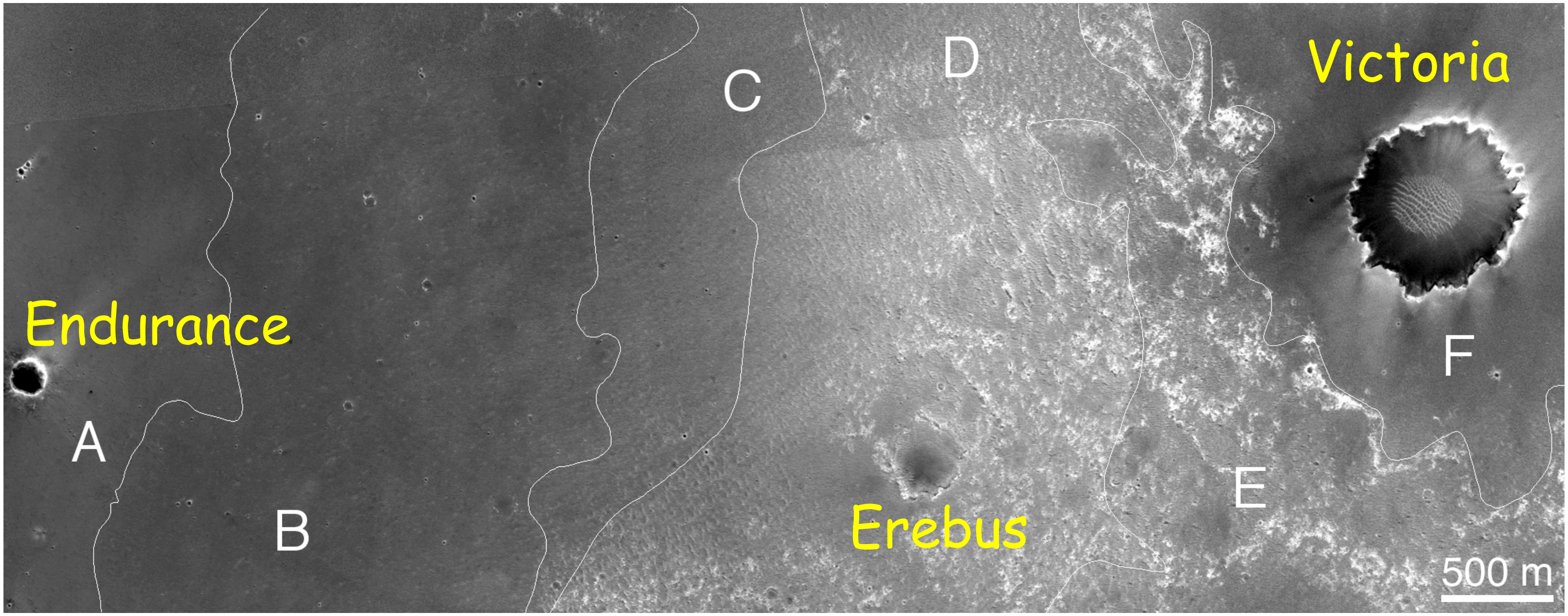
I’ll try to address:

- ❑ Some examples of landed spacecraft capabilities, the science that enables, and lessons learned for our current focus on ages, rates, and processes

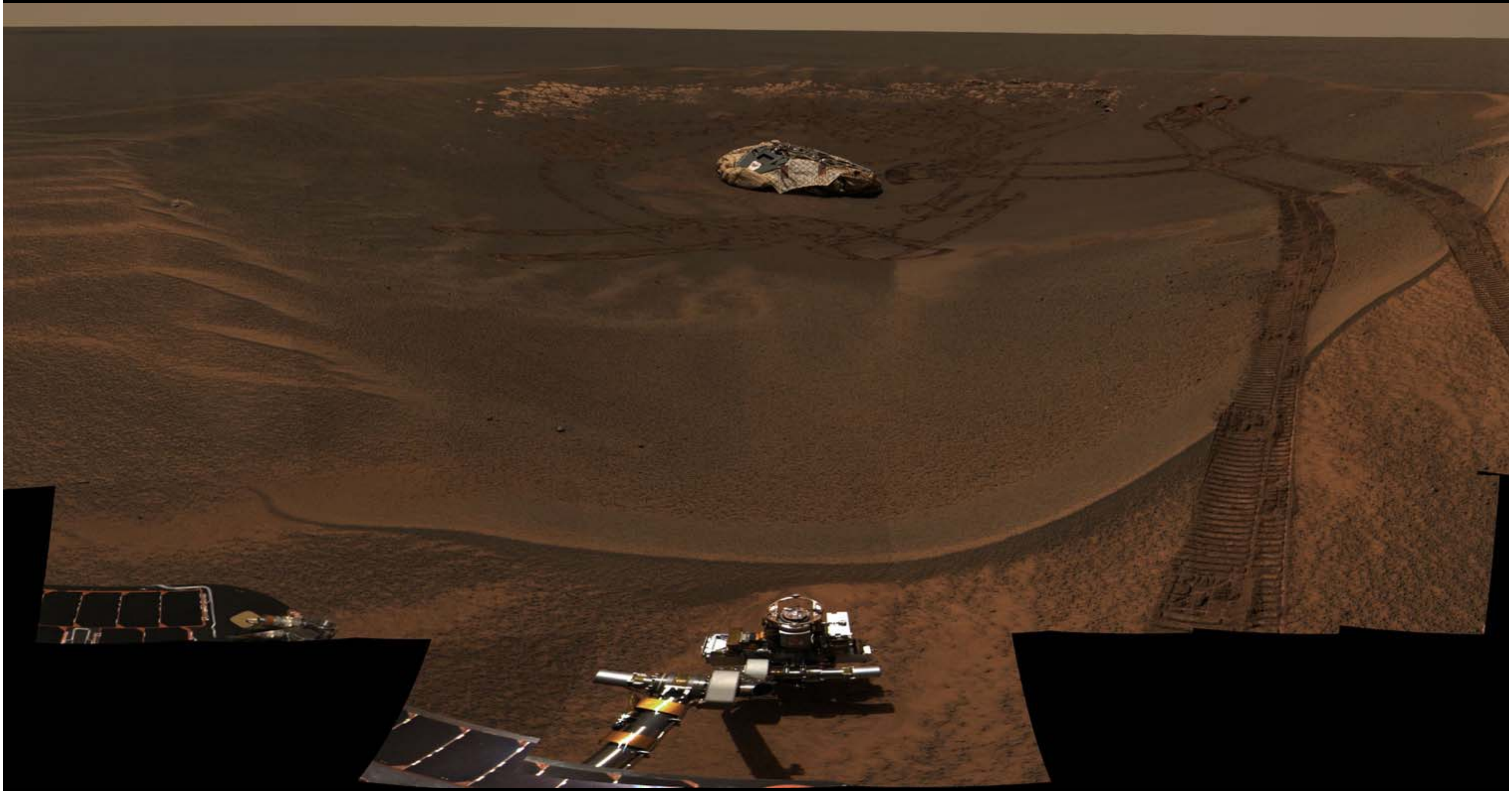
- ❑ John Eiler’s prompts -
  Issues in organizing and operating landed missions
  Changes and challenges facing us

I’m not going to talk about worthy goals, but instead will focus on how surface operations constrain those goals, and where technical bottlenecks may affect the platforms that carry our instruments

Opportunity in Meridiani Planum:
A classic example of what lander science can do for stratigraphy
(the abbreviated version since you already know all about this)

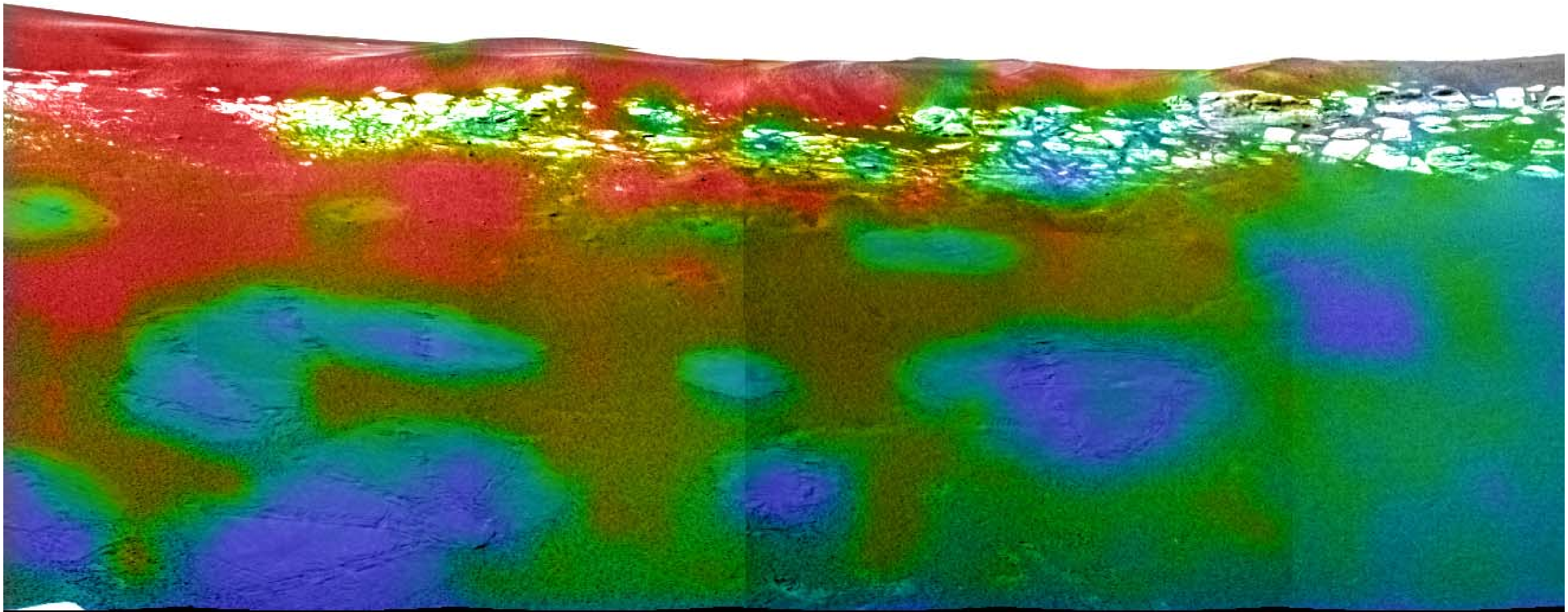


The Lion King Panorama



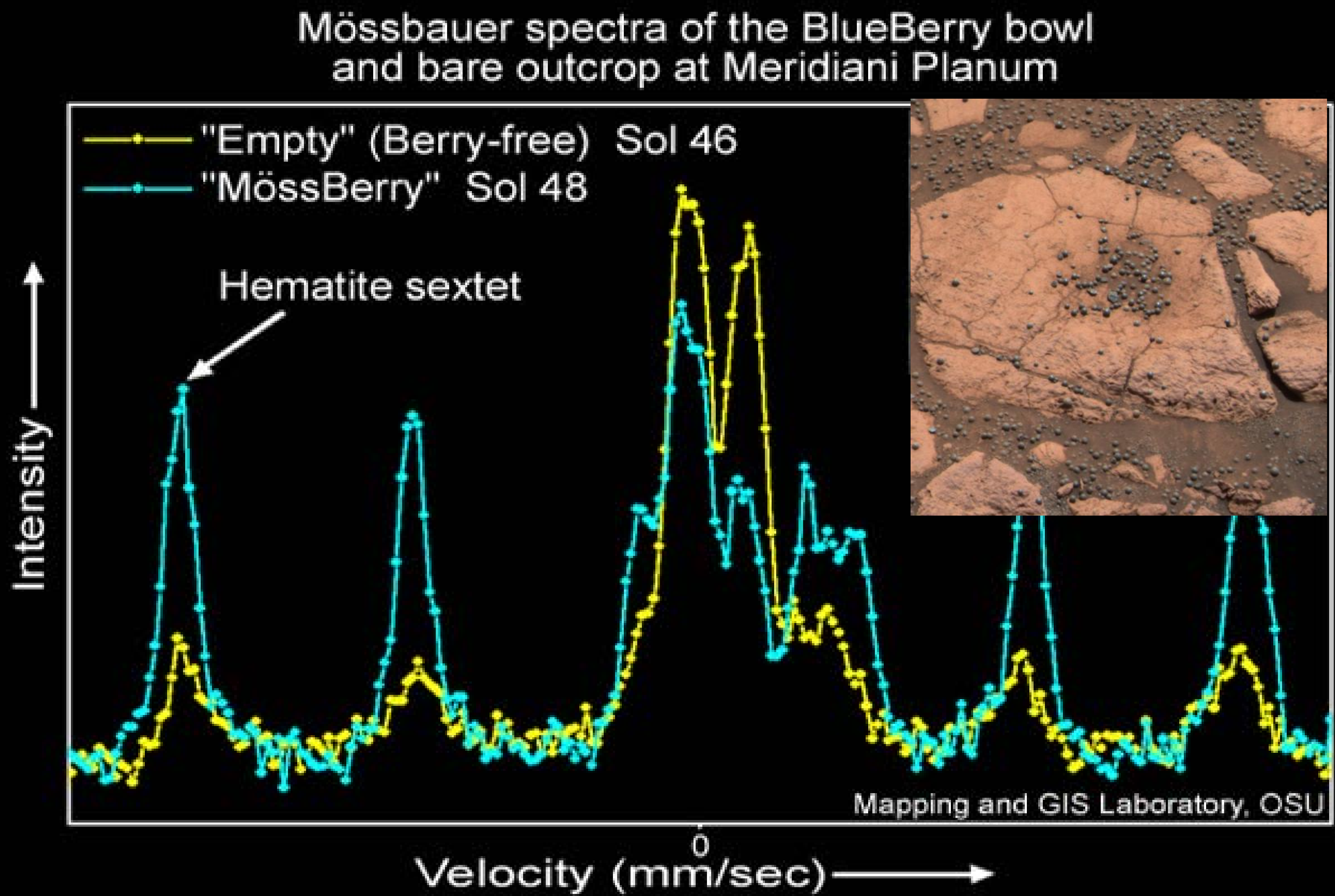
What if we hadn’t had mobility?

MiniTES Hematite Map



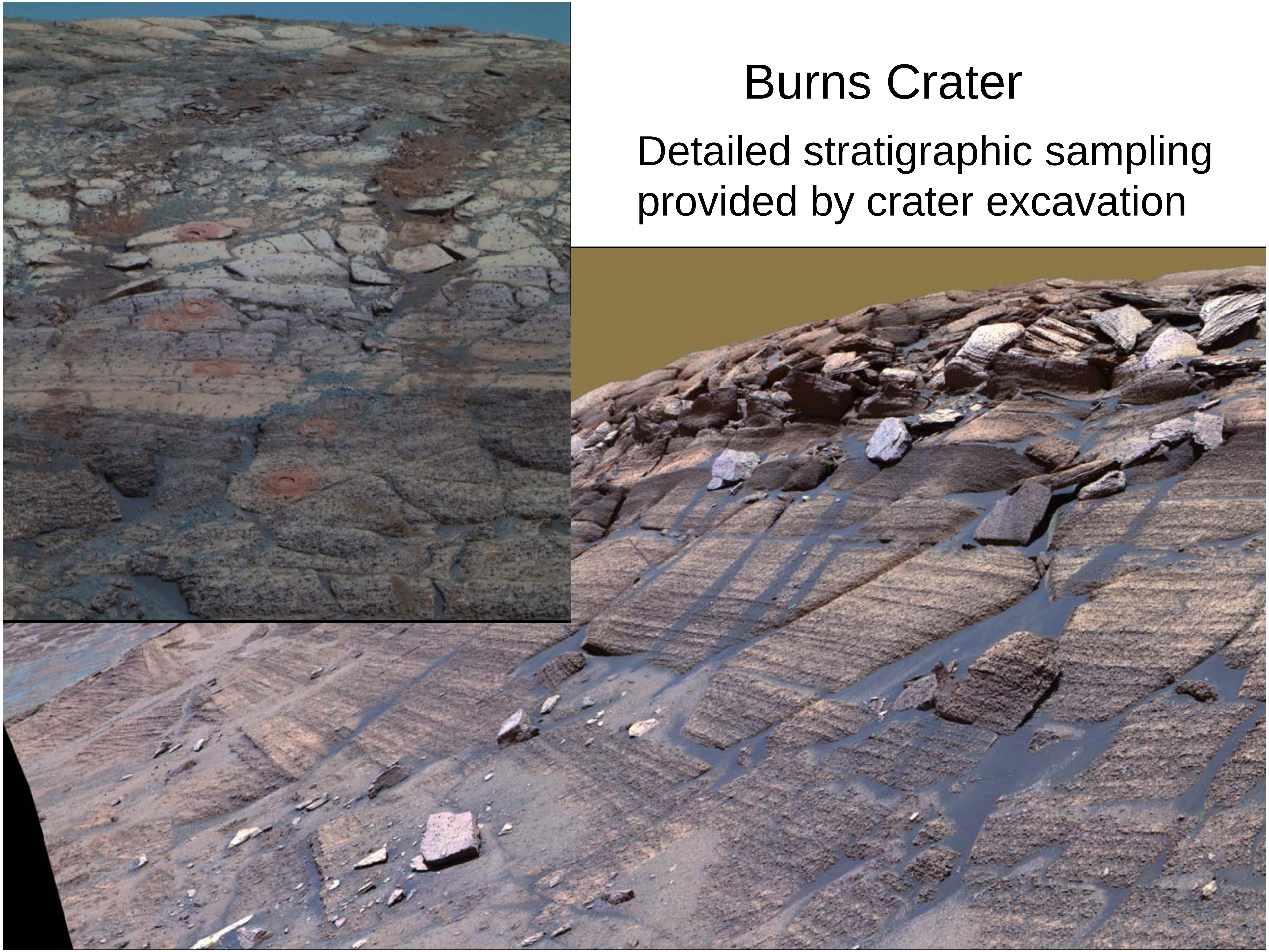
Context provided by remote sensing

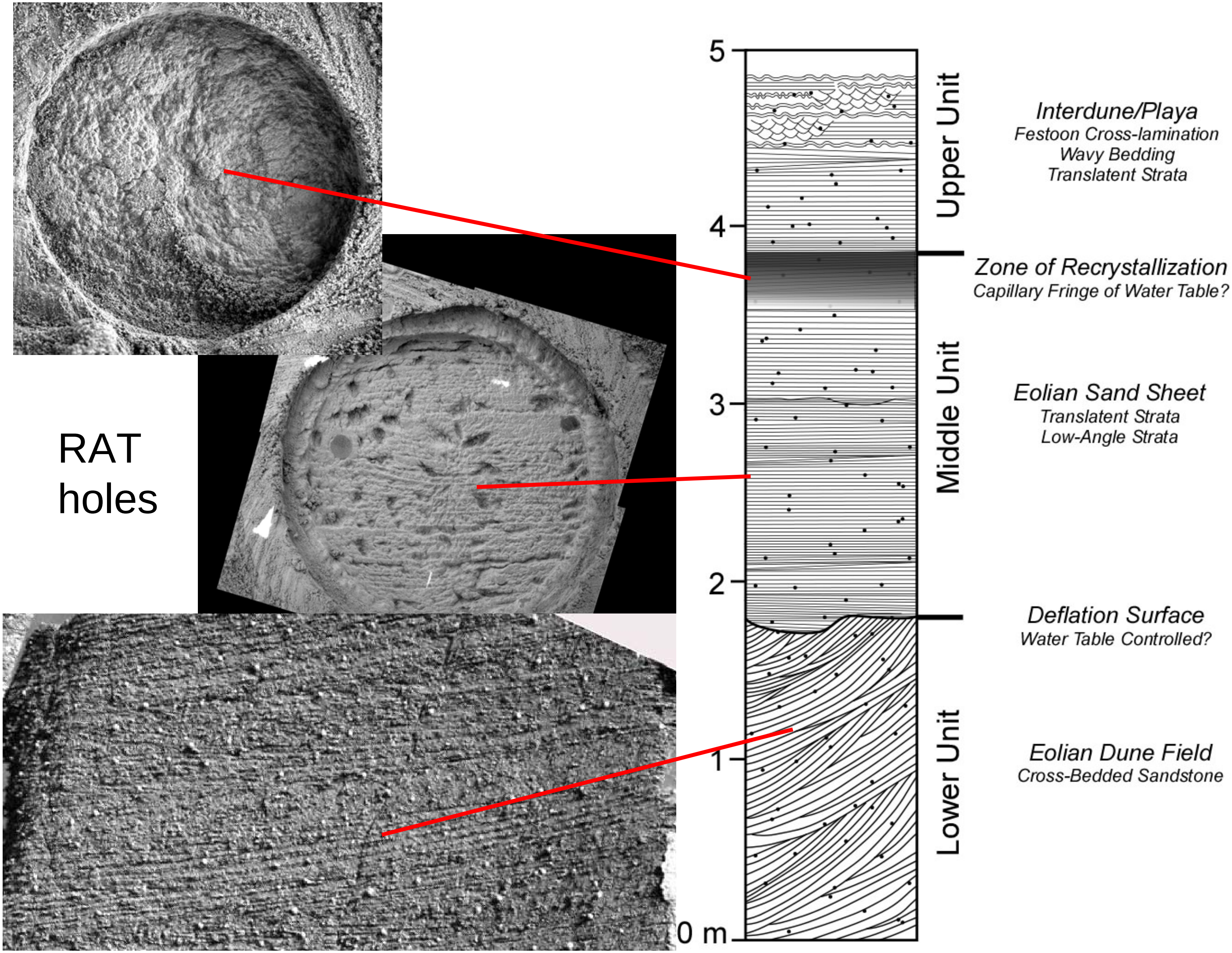
Complements remote sensing data



Burns Crater

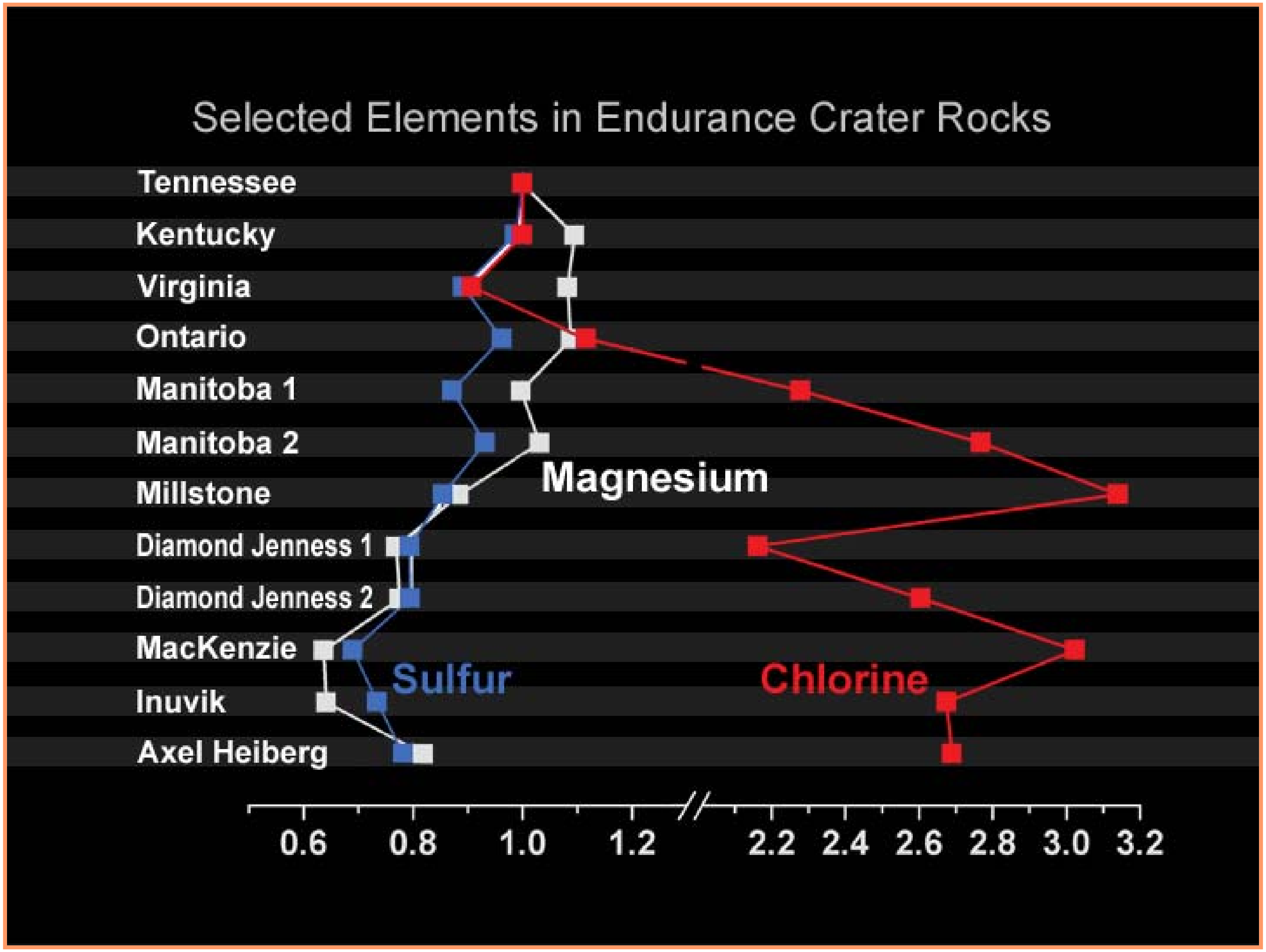
Detailed stratigraphic sampling provided by crater excavation

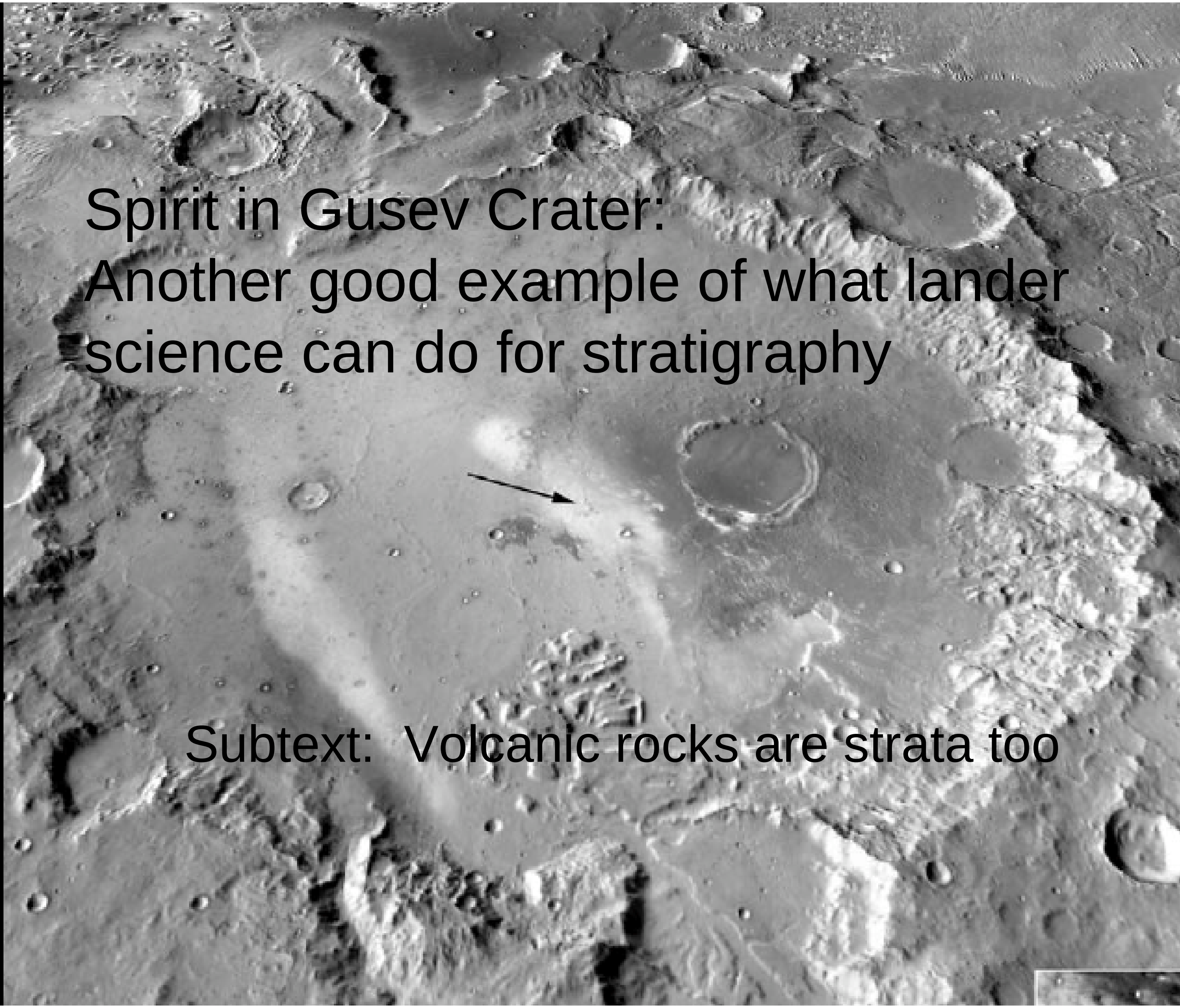


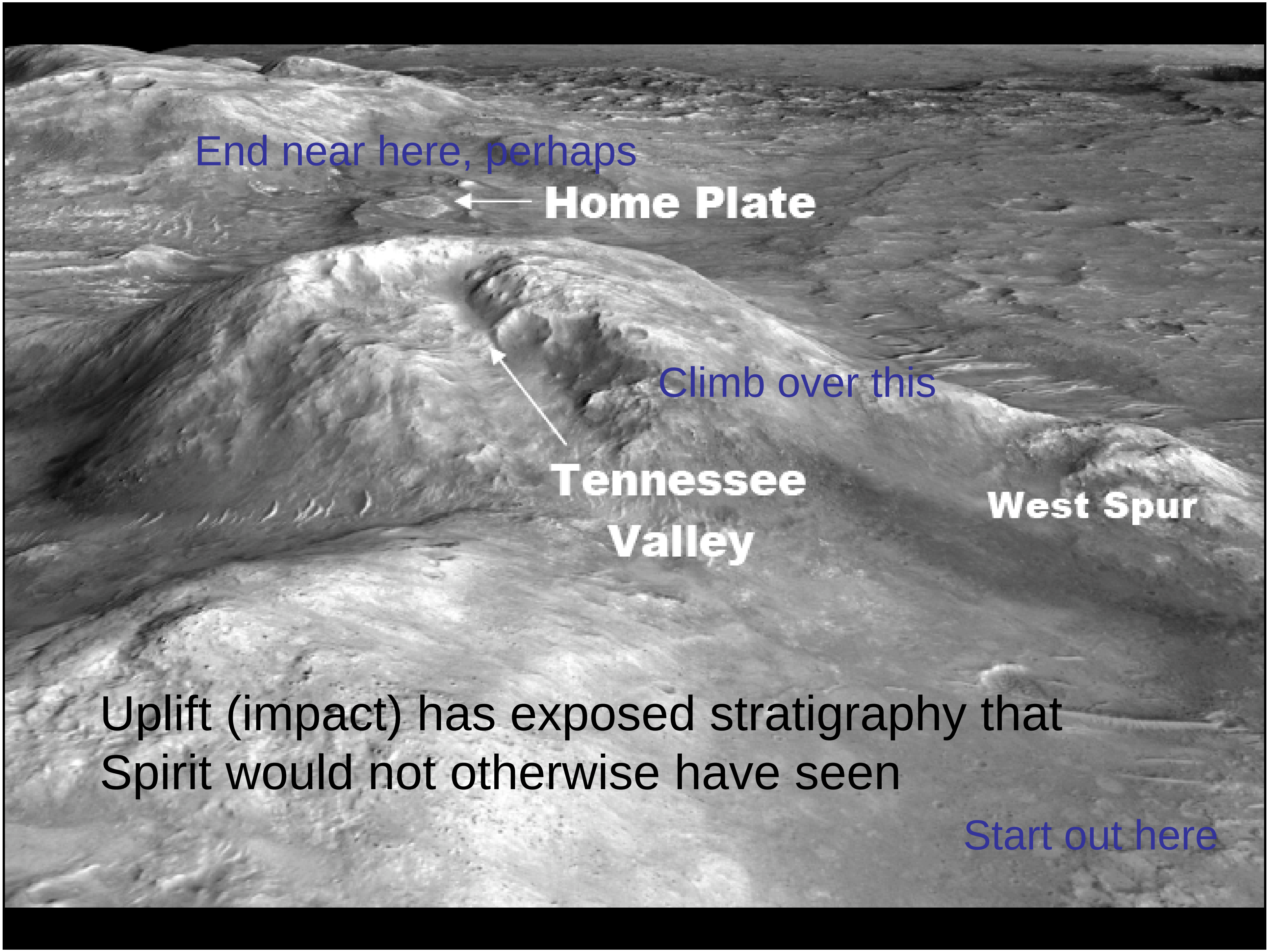


RAT
holes
5
4
3
2
1
0 m
Upper Unit
Middle Unit
Lower Unit
Interdune/Playa
Festoon Cross-lamination
Wavy Bedding
Translatent Strata
Zone of Recrystallization
Capillary Fringe of Water Table?
Eolian Sand Sheet
Translatent Strata
Low-Angle Strata
Deflation Surface
Water Table Controlled?
Eolian Dune Field
Cross-Bedded Sandstone

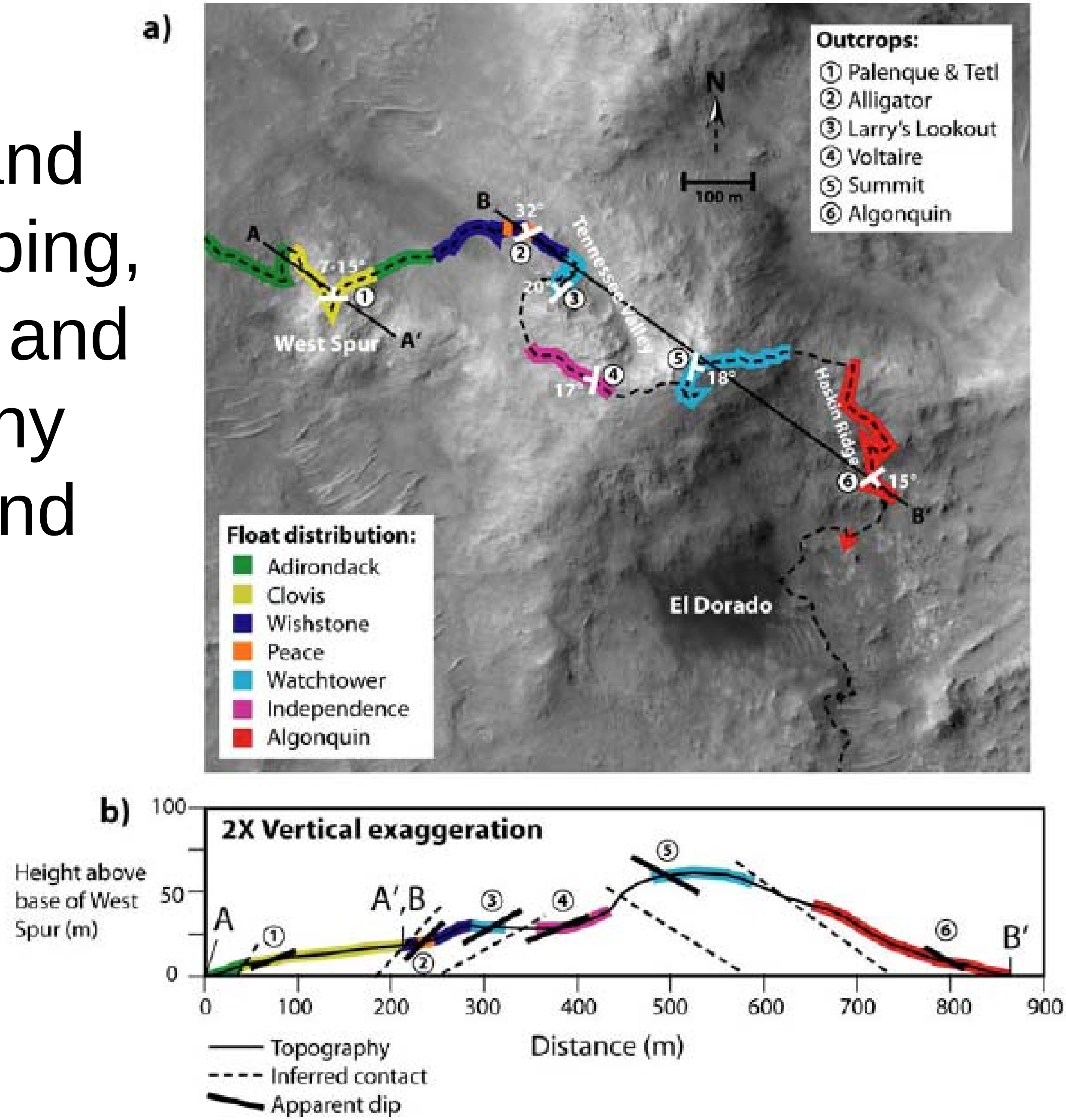
Chemostratigraphy




Spirit in Gusev Crater:
Another good example of what lander science can do for stratigraphy
Subtext: Volcanic rocks are strata too

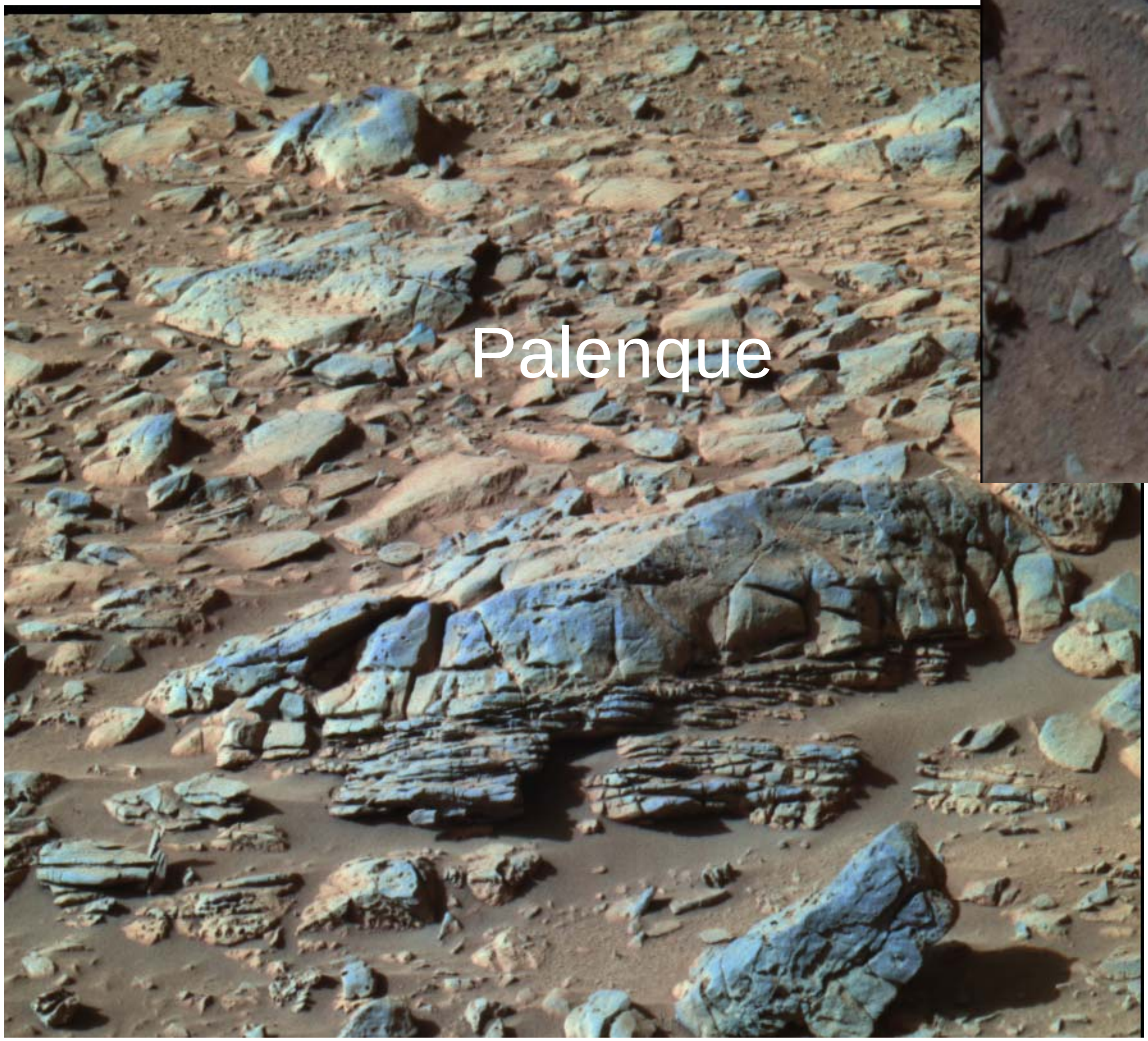

End near here, perhaps
Home Plate
Climb over this
Tennessee
Valley
West Spur
Uplift (impact) has exposed stratigraphy that
Spirit would not otherwise have seen
Start out here

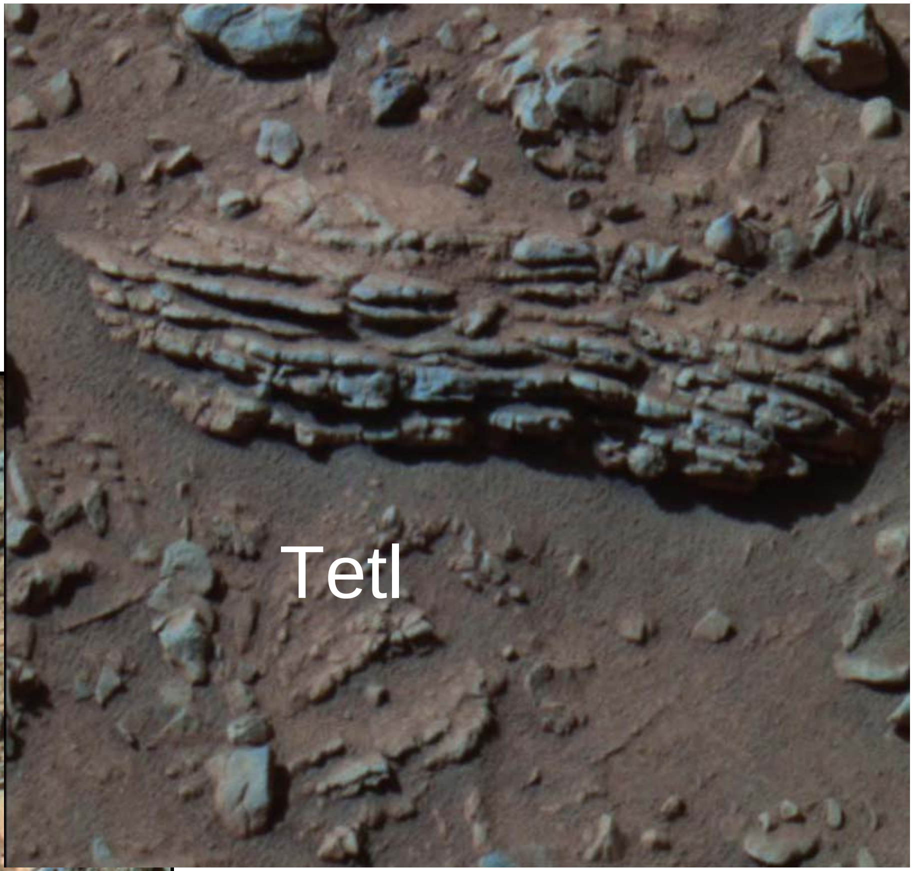
Outcrop and float mapping, structure, and stratigraphy on Husband Hill



This would have been impossible from orbit

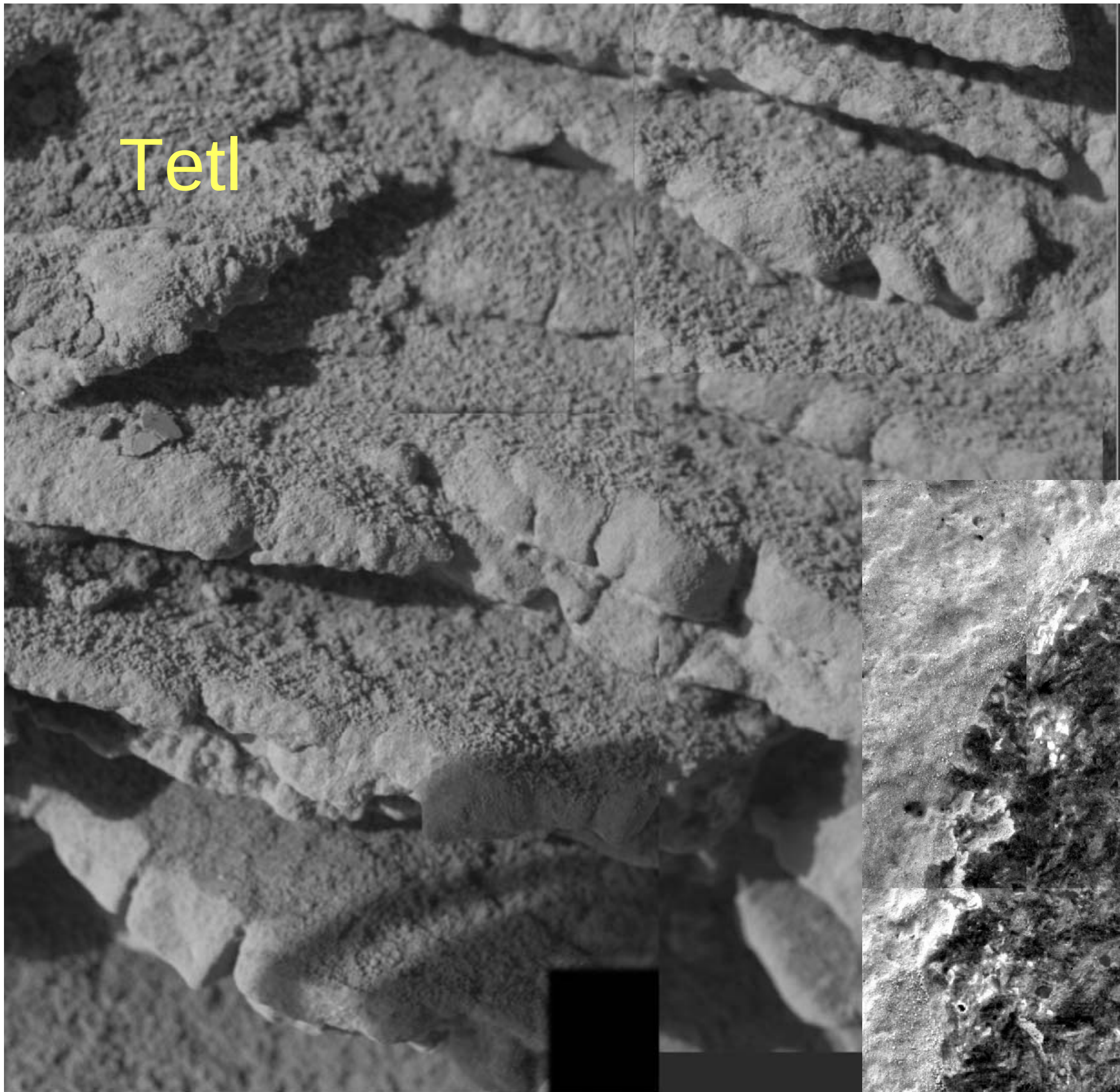
Stratigraphy up close

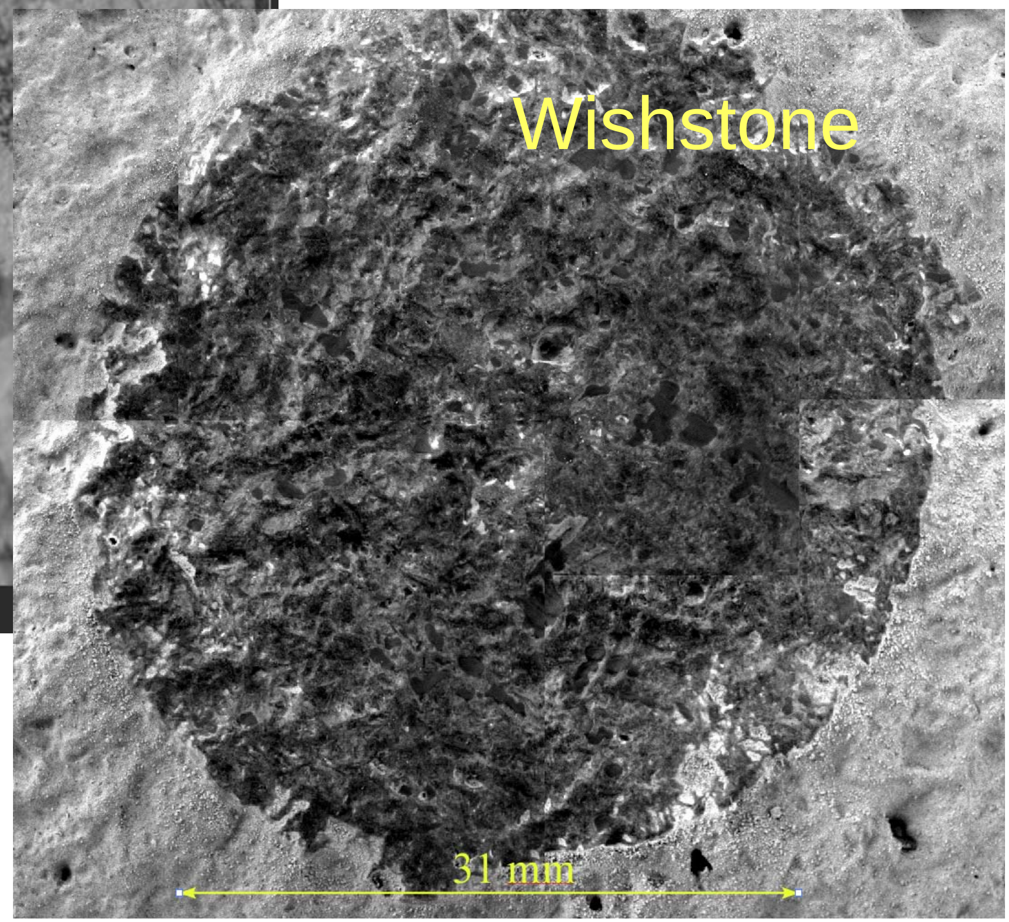




Provides scale and orientation measurements

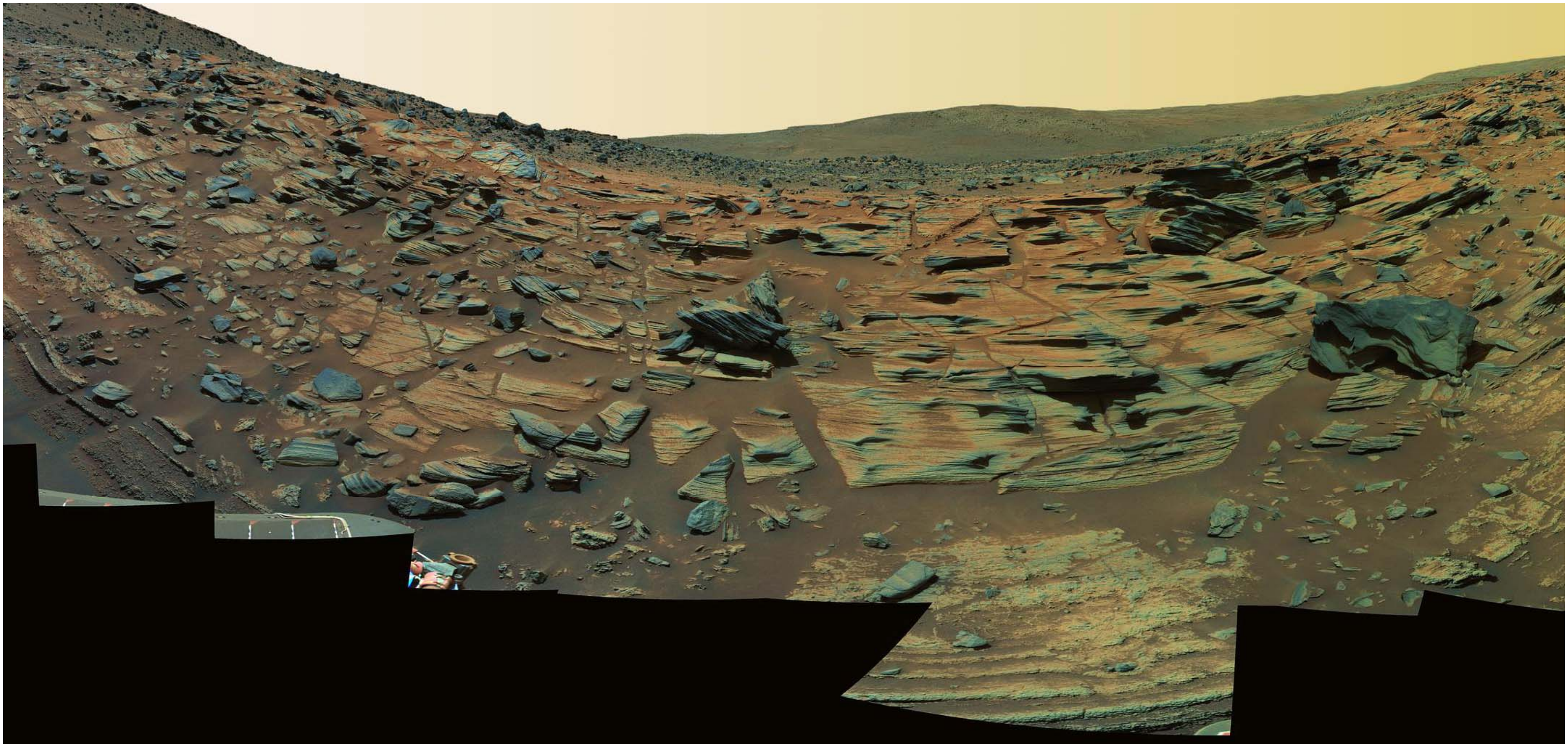
Up Closer



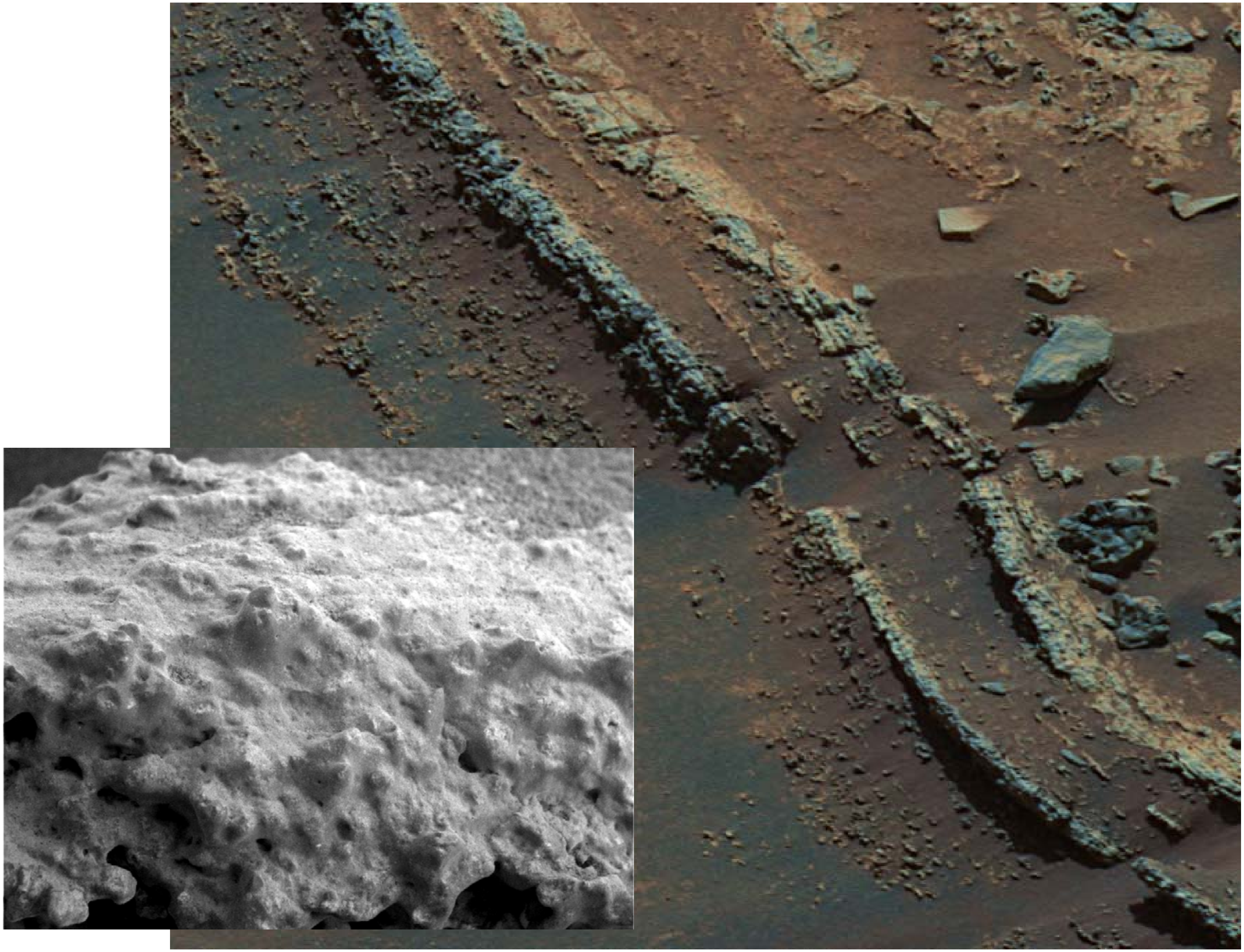


Textures constrain origins

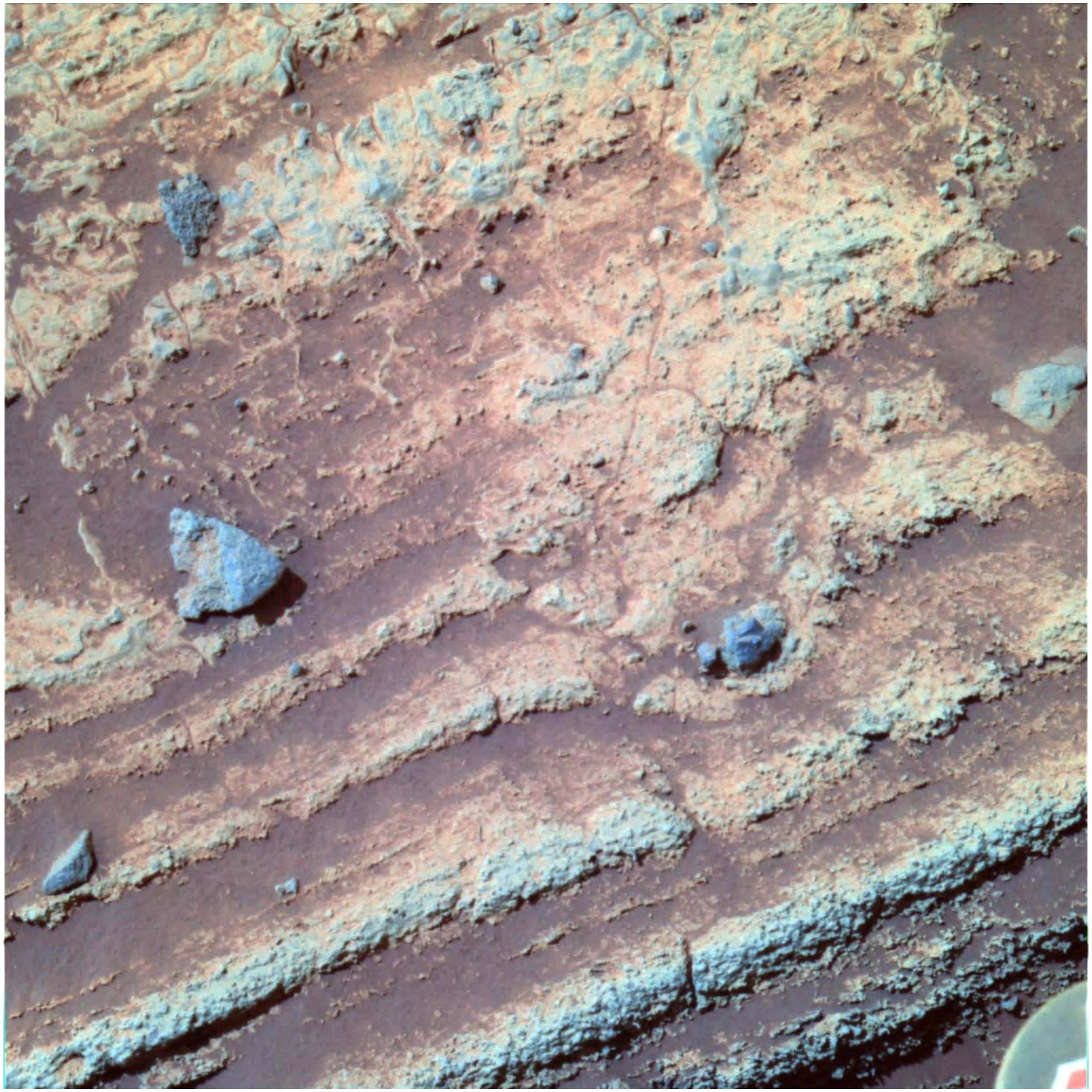
Home Plate



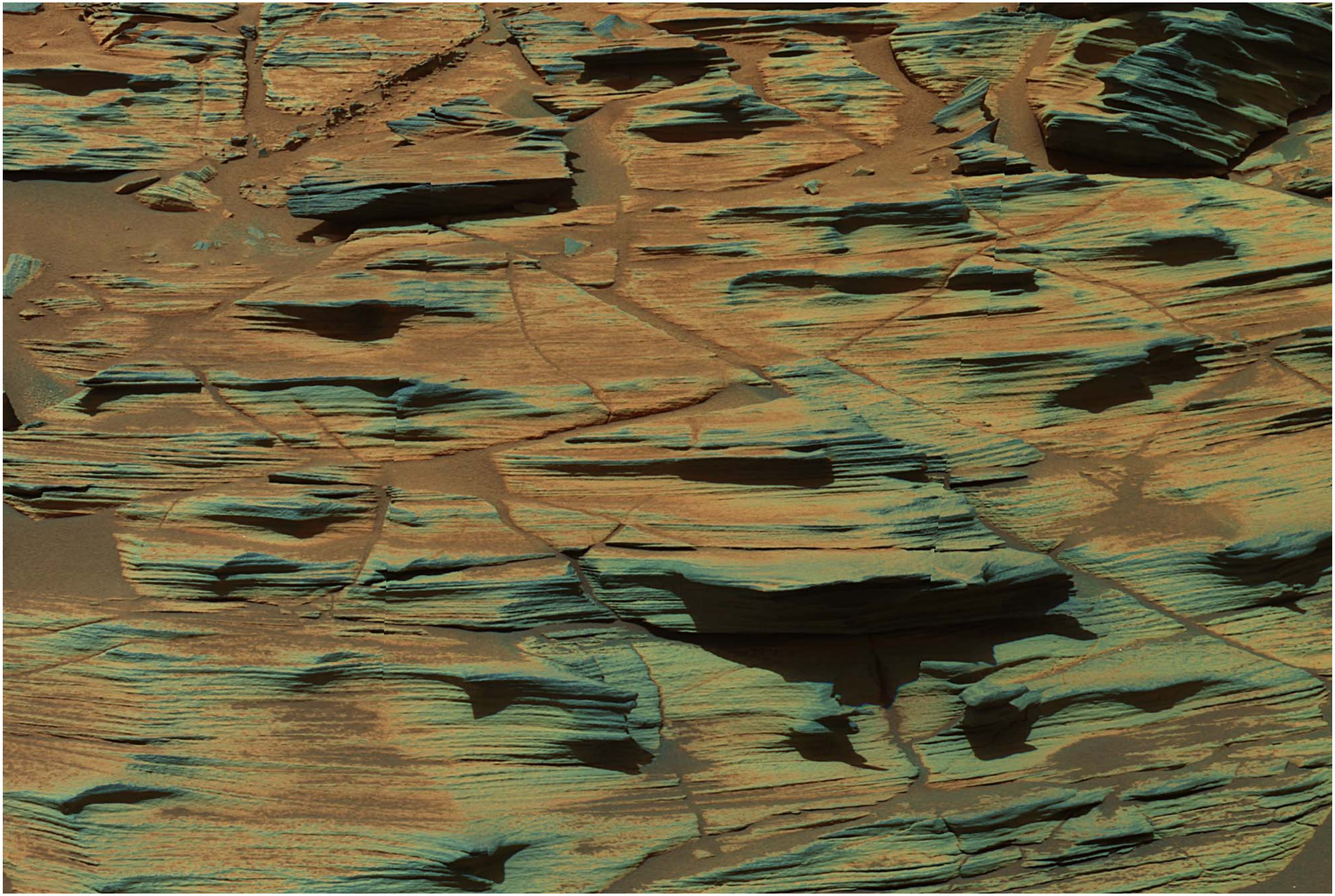
Coarse-Grained Lower Unit



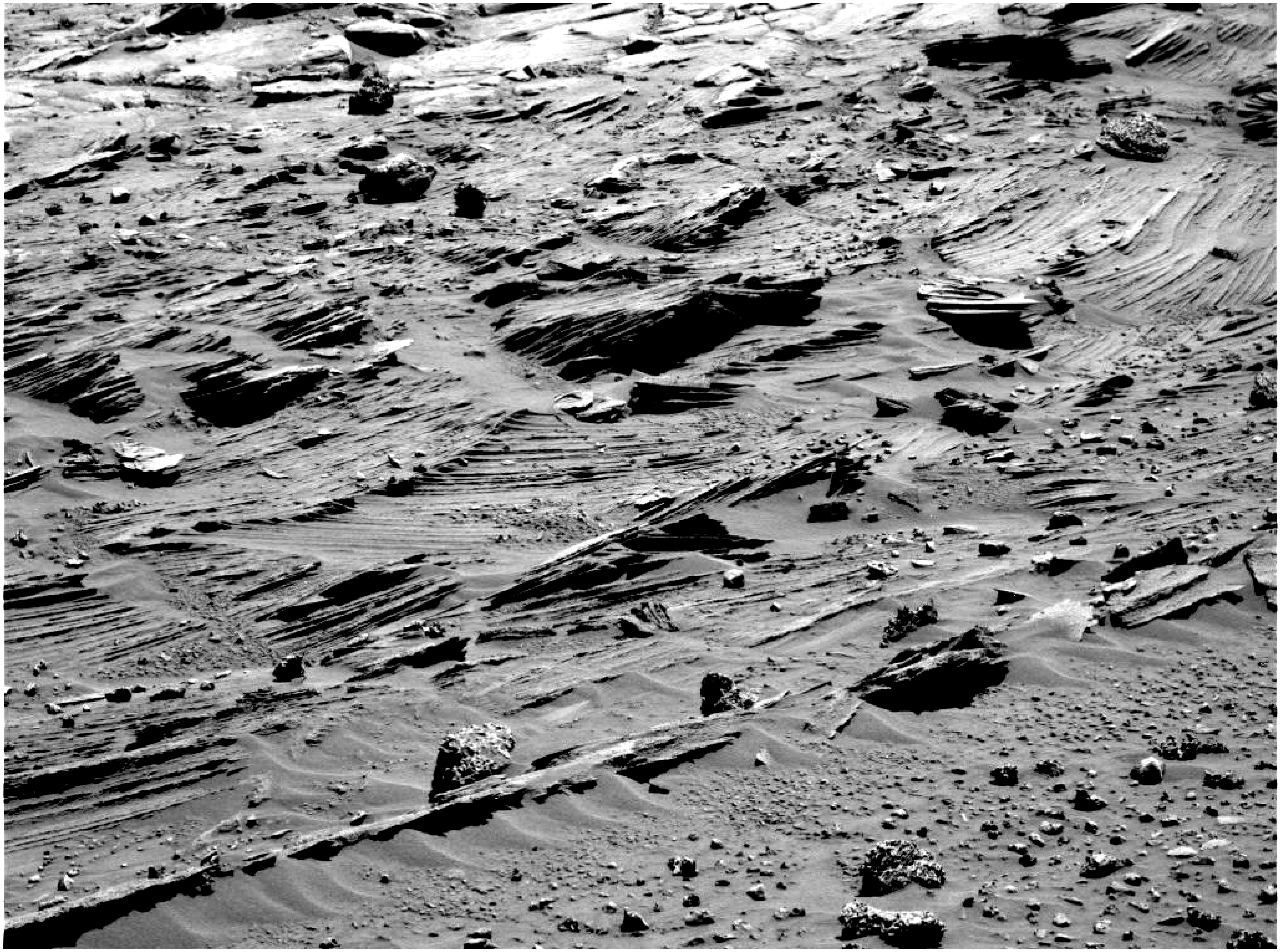
Probable Bomb Sag In Lower Unit



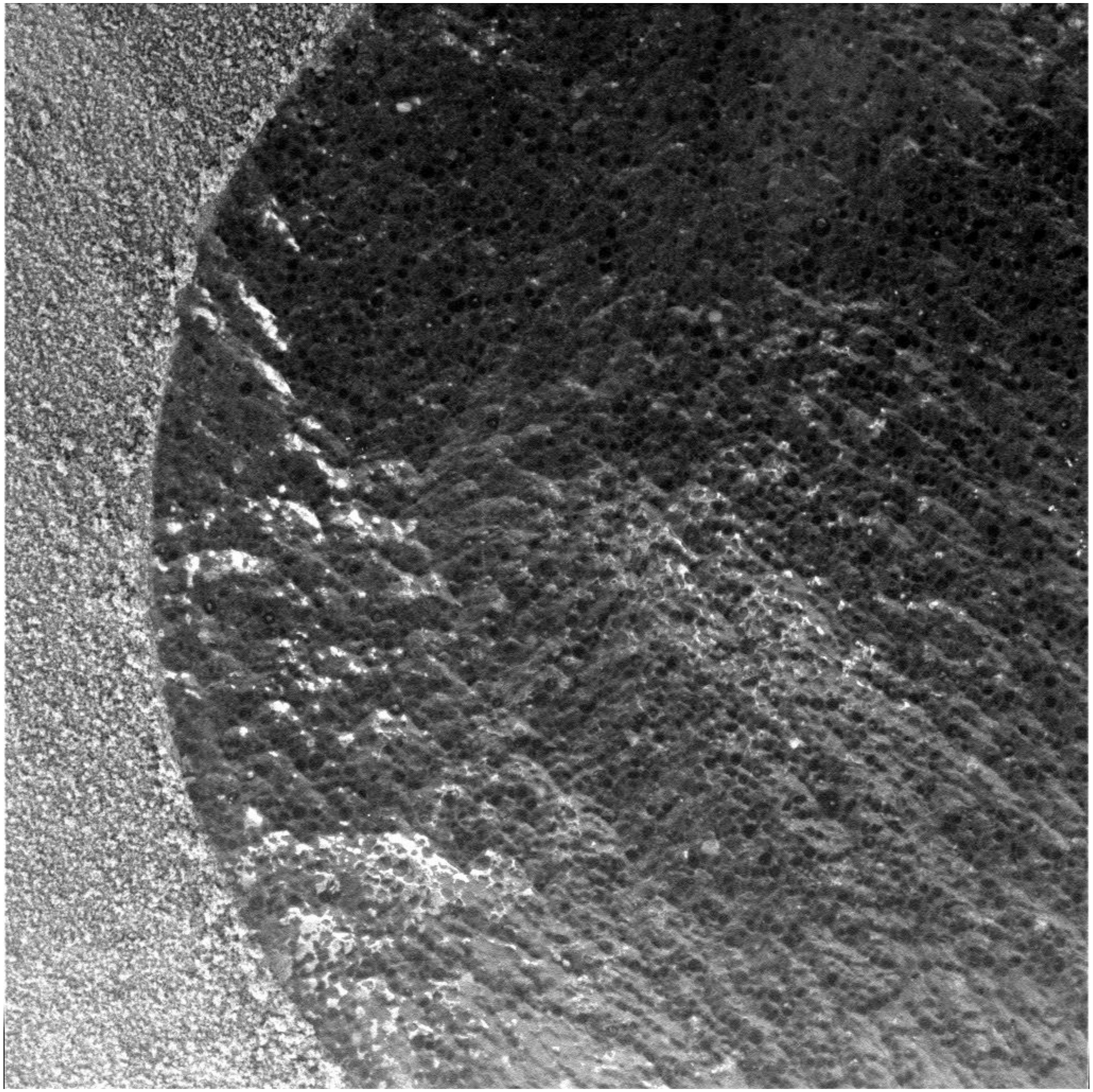
Fine-Grained Upper Unit



Cross-Stratification In Upper Unit

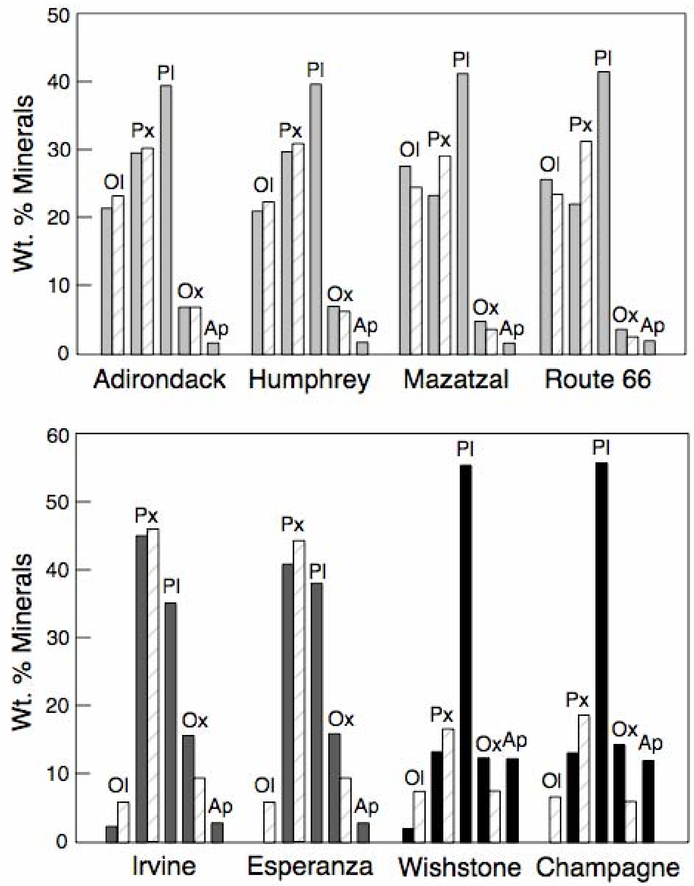


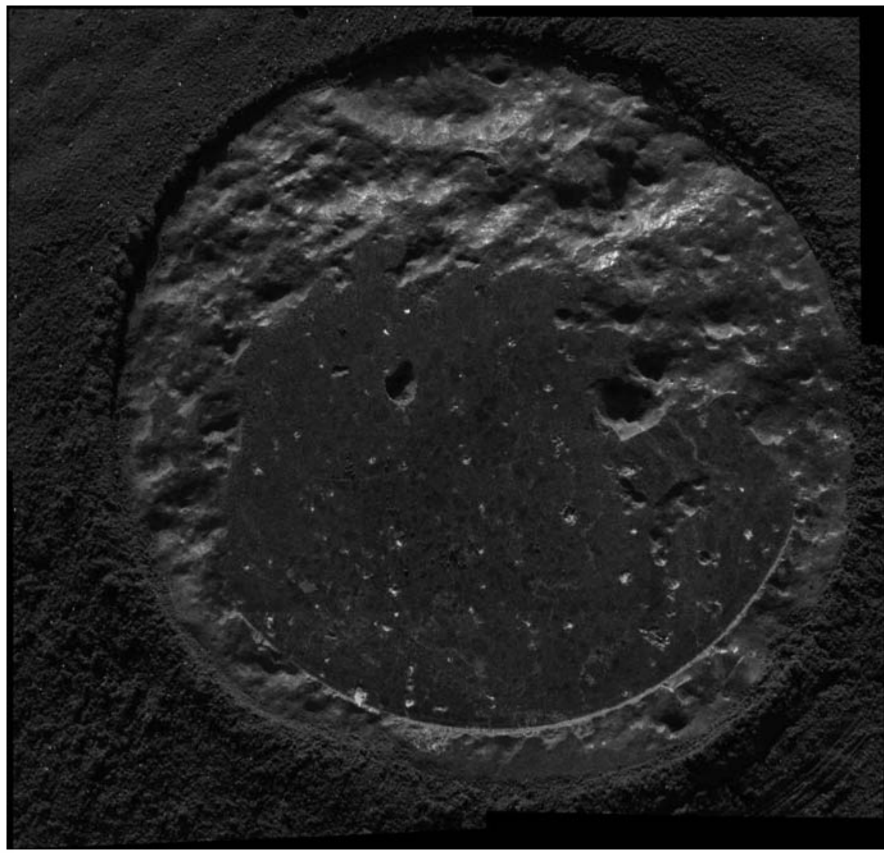
Sorting And Rounding In Upper Unit



Understanding mineralogy and petrologic context

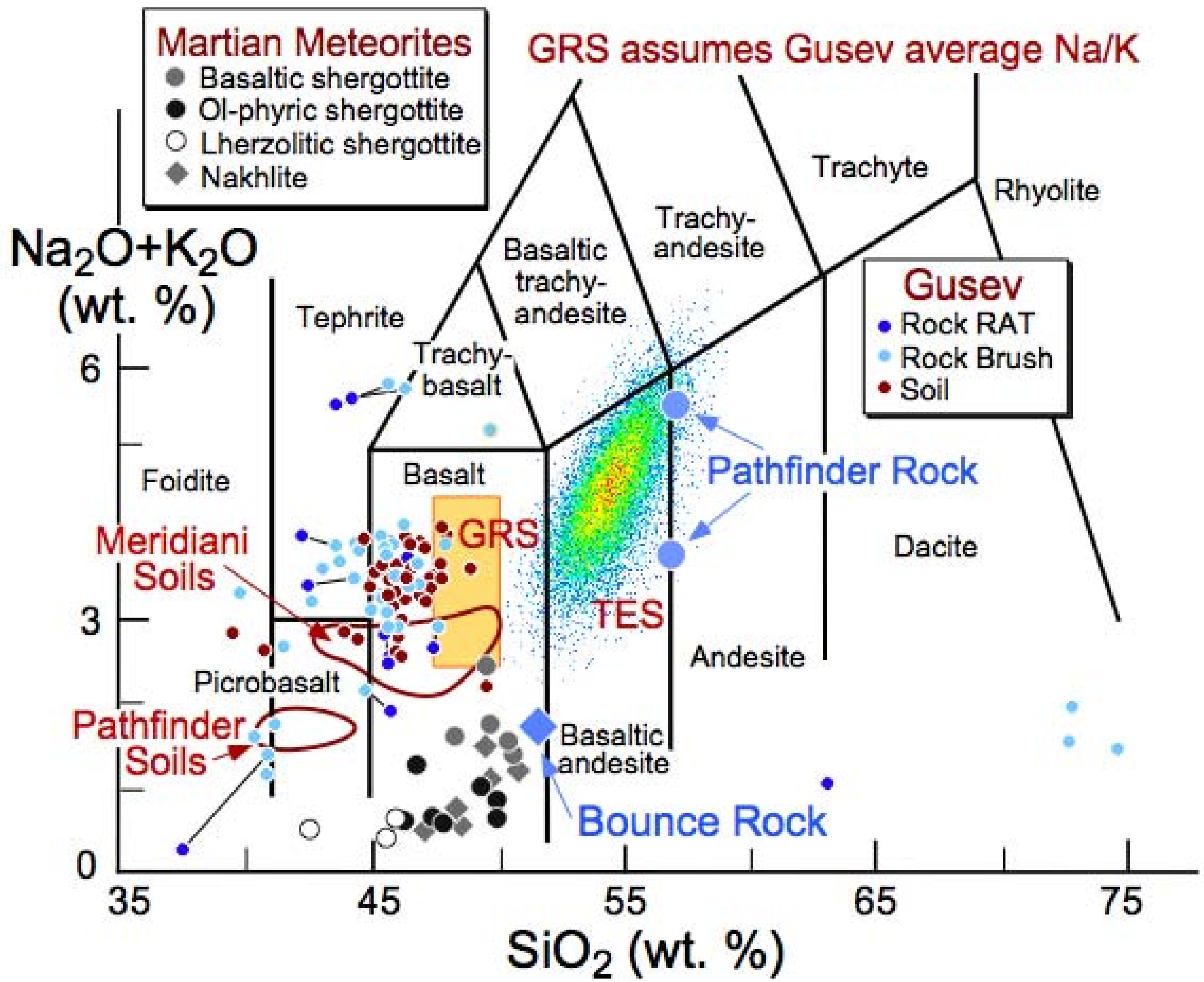
- Not just a few spectrally observable minerals, but a mineral assemblage
- Exactly what event are you dating?



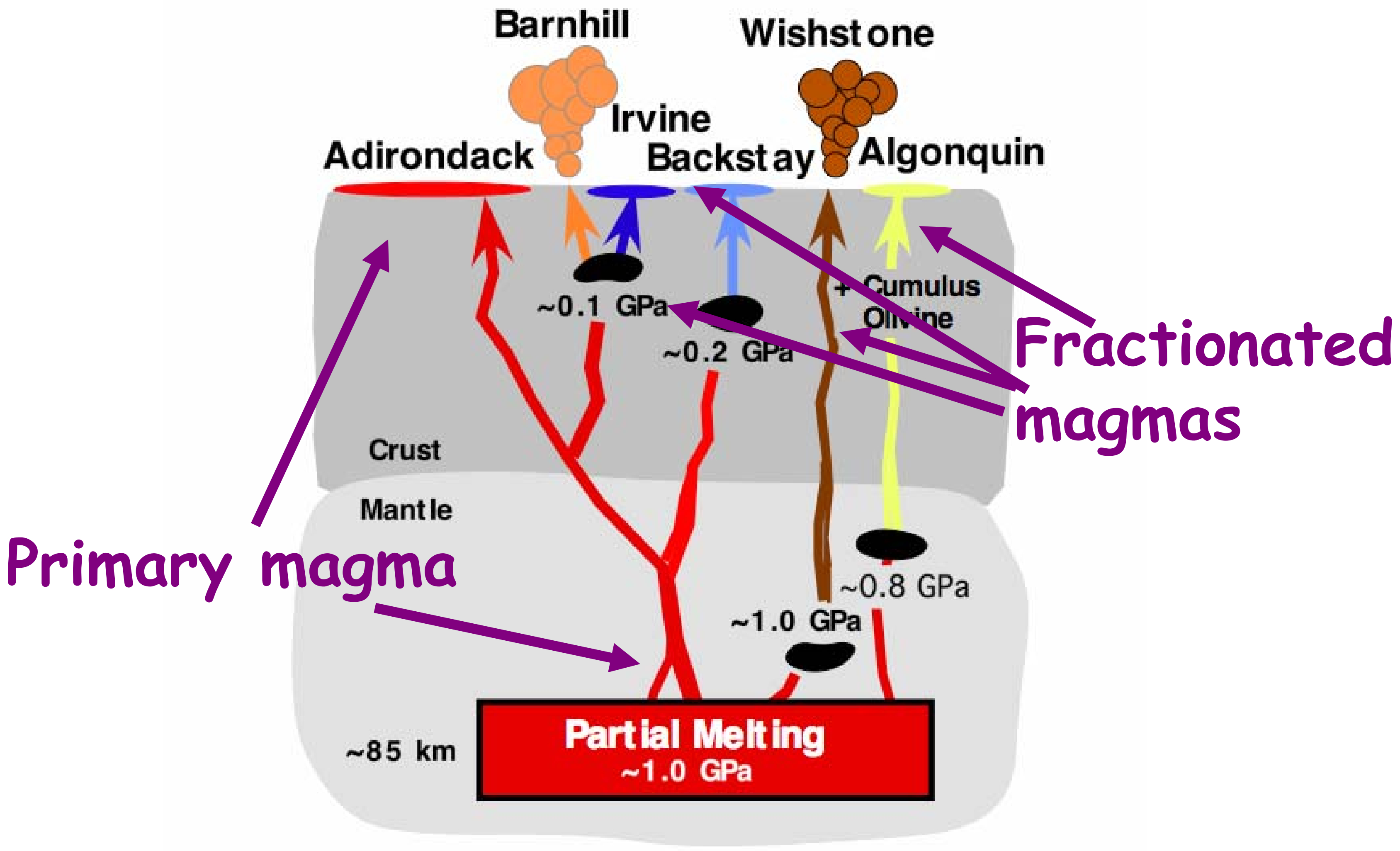


Geochemistry

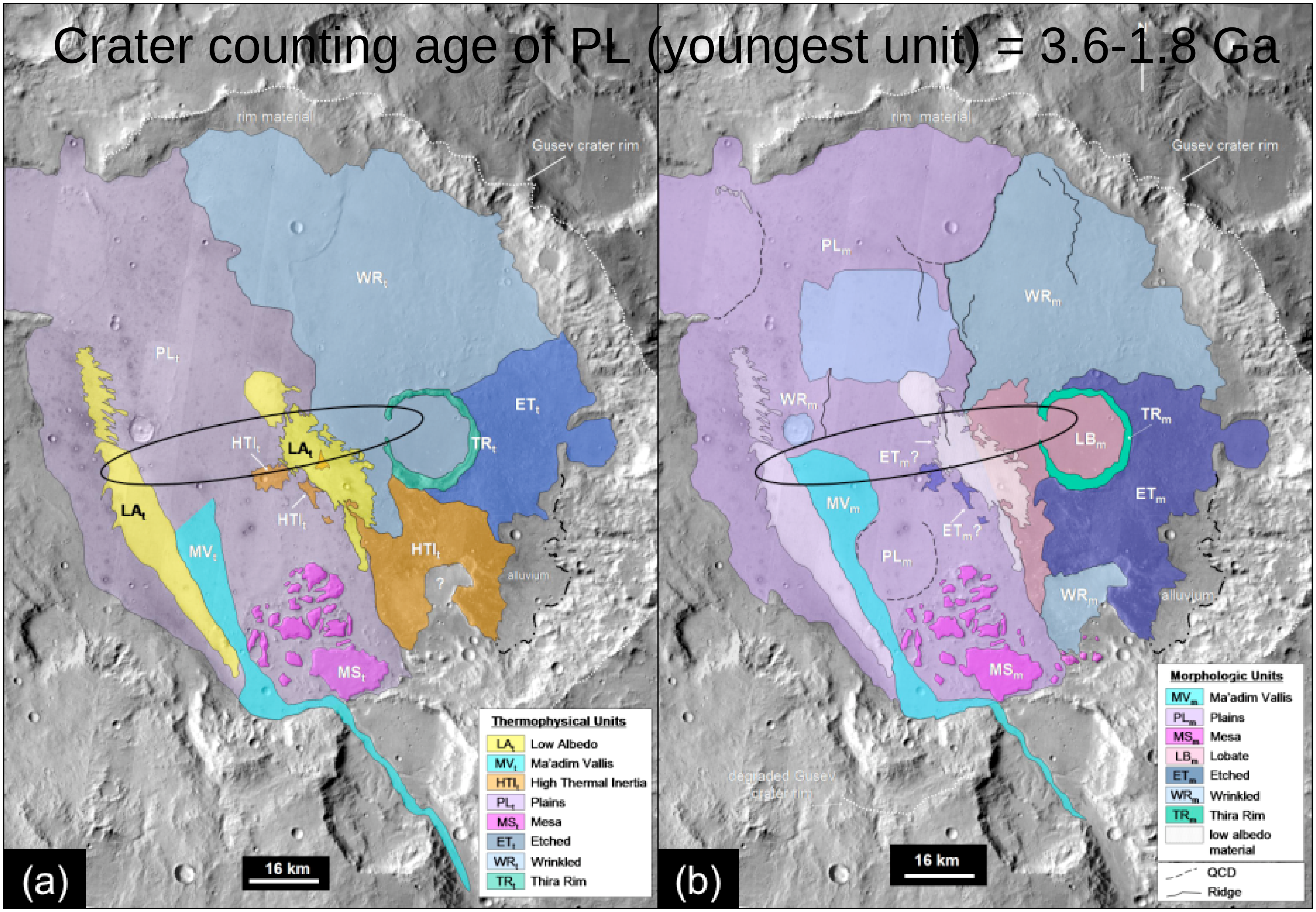
- Document chemostratigraphy and map variations
- Significant even if we don't measure trace elements



Understand processes, in this case igneous



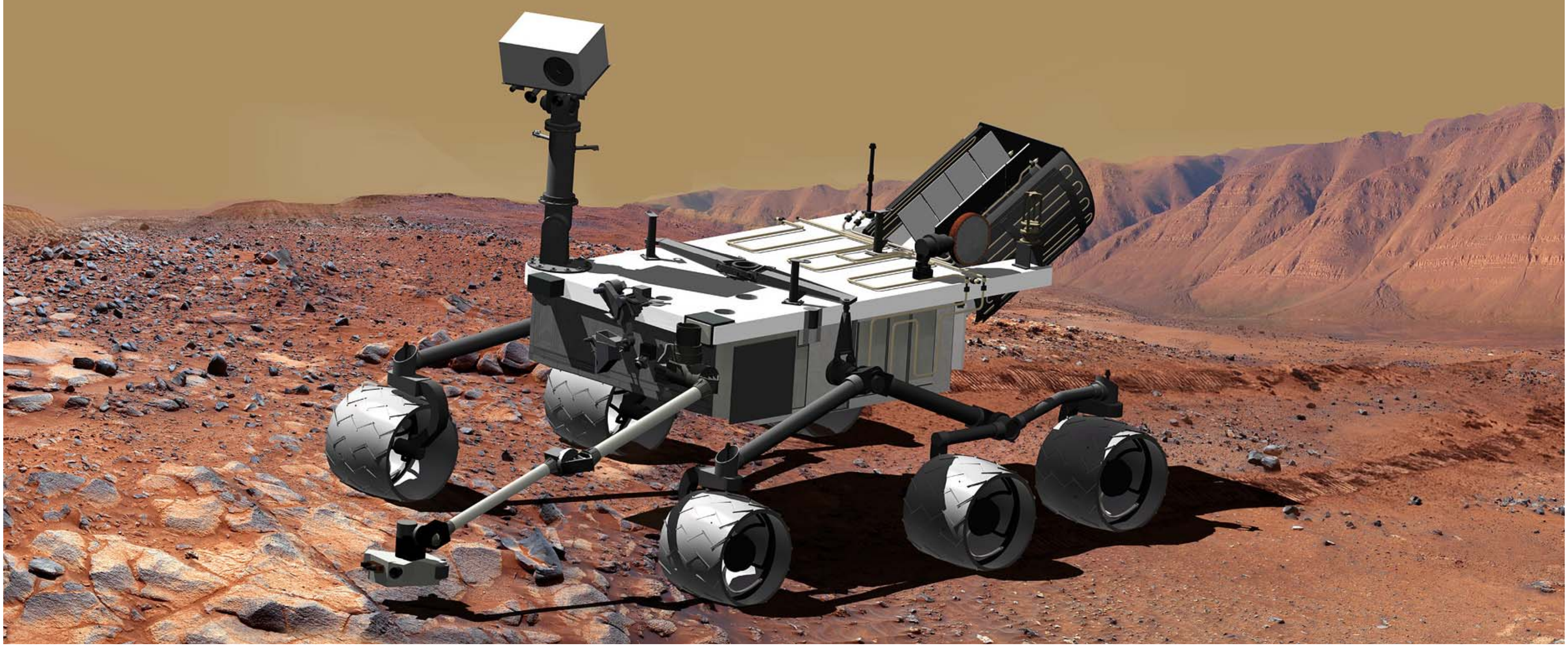
Gusev chronology is iffy at best



Lessons Learned,
Relevant to Ages, Rates, Processes in Strata

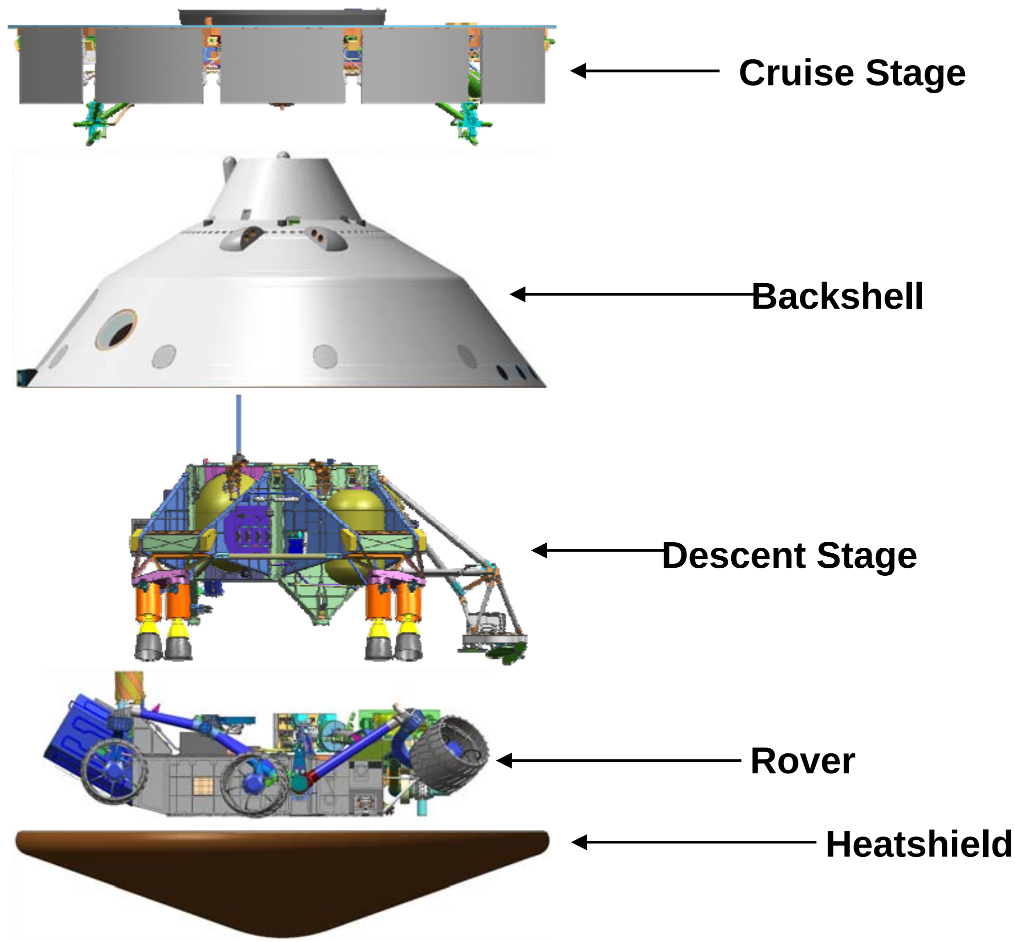
- Drive, stupid!
- Coordinated attack - complementary instrument package, with both close-up and stand-off observations
- It's what's inside that counts - need access to rock interiors (but we want to study the altered rinds too)
- Geology rules - science teams must learn to operate in the mode of a field geologist
- There is a free lunch - we don't need to drill to access stratigraphy (but we do need to climb/descend)
- Tempus fugit - surface ops take much longer than expected
- Winter is hell - power is the most critical constraint on operations

Some issues to think about when contemplating a lander mission



Organizing a Mission and Getting Selected

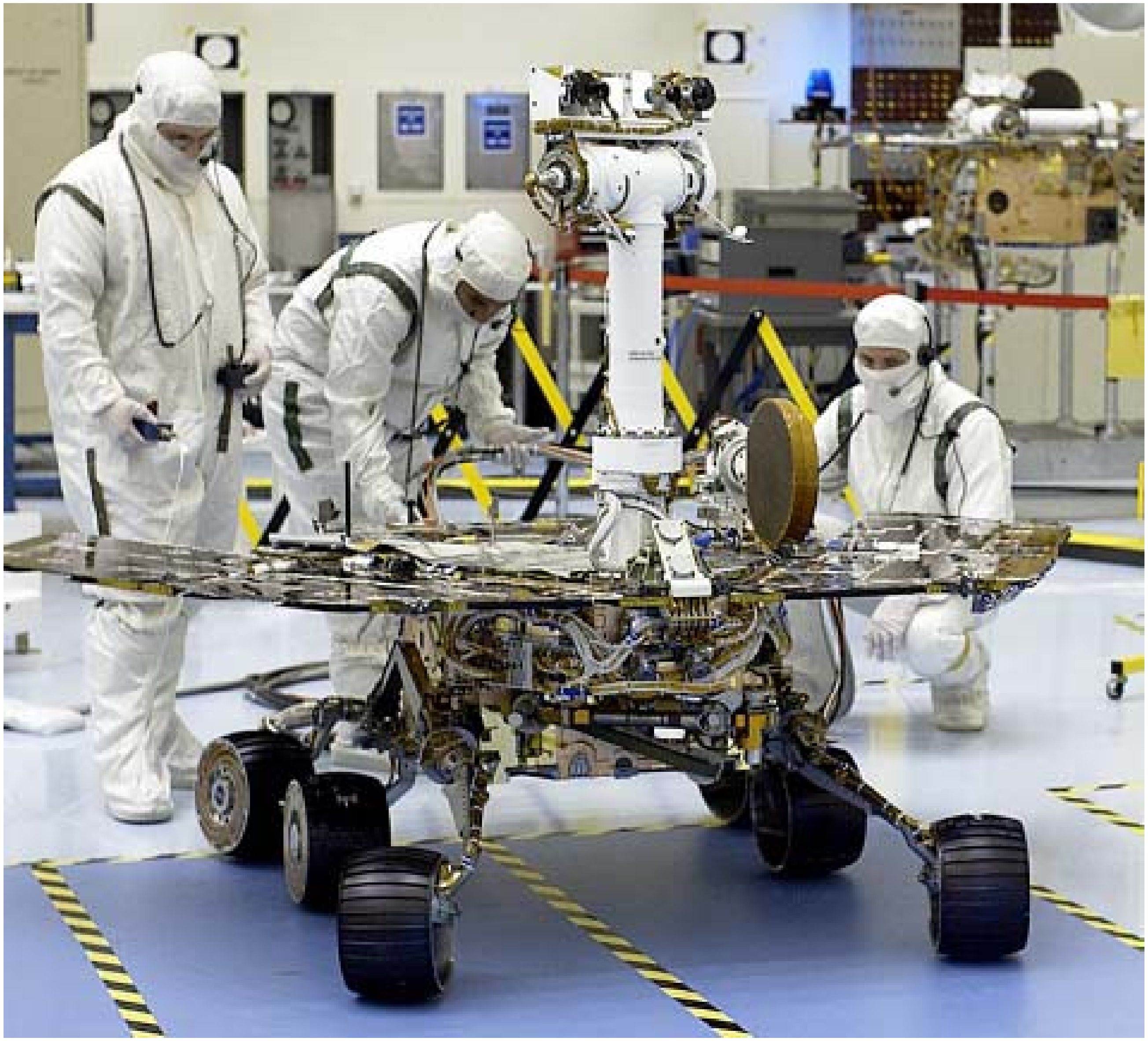
MSL Spacecraft
Major Elements



Organizing a Mission and Getting Selected

- Contrasting mission models -
  MER and MSL
- Controlling financial and technical risks -
  flight heritage
  engineers always want something new
  assumptions about the pace of development
- Power issues -
  we always need more (e.g. ASRG)
- Science should be paramount -
  but it isn't always (don't give in easily)
  instrument complementarity
- Must sell it to the broader community

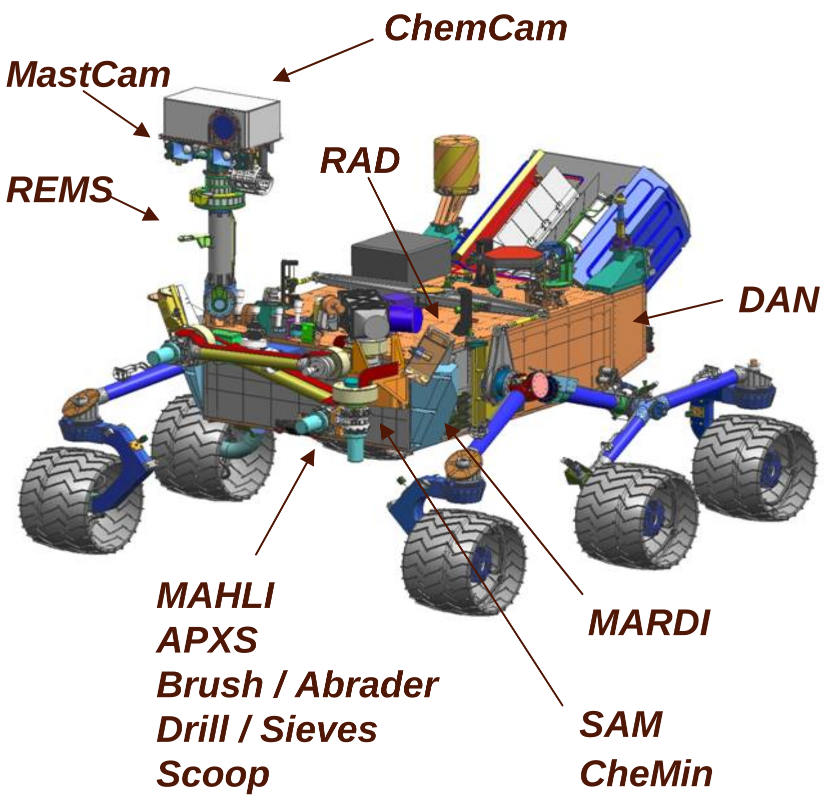
Conducting a Mission



Conducting a Mission

- Getting ready for flight -
  - Meeting delivery schedules
  - Testing and integration
- Training the team (scientists and engineers)
- Mission ops -
  - Tactical ops and strategic planning
  - Software support
  - Human limitations
- Shift to distributed mode of operations
- Science results
  - Rules of the road
  - Data archiving

Changes/Challenges over the Next Decade



Changes/Challenges over the Next Decade

- More autonomous ops, especially mobility?
- More power -
  - Round-the-clock ops?
  - Mission lifetimes that seem to last forever?
- EDL and other engineering designs keep changing
- Sufficient communication relays?
- Sample caching for future return?
- Needed improvements in sample acquisition/handling/ preparation
- Schedule for developing new analytical capabilities
  - Isotope chronology, trace elements, mineralogy
- Planetary protection versus interesting sites