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

Mössbauer spectra of the BlueBerry bowl and bare outcrop at Meridiani Planum

"Empty" (Berry-free) Sol 46
"MössBerry" Sol 48

Hematite sextet

Mapping and GIS Laboratory, OSU
Burns Crater

Detailed stratigraphic sampling provided by crater excavation
Chemostratigraphy

Selected Elements in Endurance Crater Rocks

- Tennessee
- Kentucky
- Virginia
- Ontario
- Manitoba 1
- Manitoba 2
- Millstone
- Diamond Jenness 1
- Diamond Jenness 2
- MacKenzie
- Inuvik
- Axel Heiberg

- Magnesium
- Sulfur
- Chlorine

Y-axis: Log scale
Spirit in Gusev Crater: Another good example of what lander science can do for stratigraphy

Subtext: Volcanic rocks are strata too
Uplift (impact) has exposed stratigraphy that Spirit would not otherwise have seen.
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
Textures constrain origins

Wishstone

31 mm
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

Crater counting age of PL (youngest unit) = 3.6-1.8 Ga
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

- Cruise Stage
- Backshell
- Descent Stage
- Rover
- Heatshield
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
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- 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
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• 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