The Geomorphology of the Proposed MSL Field Site in Gale Crater

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Anderson & Bell (2010)
Ellipse Science: Alluvial Fan

- Branching channels on the crater wall end in a fan-shaped feature.

- The fan can be divided into two units, distinguished by texture and thermal inertia (TI).

NASA/JPL/ASU/Fergason et al. (2006)
Low TI Fan

- Smooth surface with occasional ridges (inverted channels)
- Many craters appear filled or mantled
- May be a thin layer over High TI Fan

HiRISE Image: PSP_009716_1755
• Underlies the Low TI fan.
• High TI fan is made of fractured, layered rock.
• Many craters are sharply defined, some are partially filled.

HiRISE Image: PSP_010639_1755
Ellipse Science: Alluvial Fan

- Fan sediment, inverted channels
  - Infer depositional process and duration

- Fan stratigraphy
  - Erosional and depositional history

- Samples of Gale crater wall (noachian crust)
  - Composition and alteration history
Much of the crater floor has a hummocky appearance.
Cemented Fractures

North and west of the alluvial fan the hummocky plains unit is rugged, with many erosion-resistant ridges (likely cemented fractures).

HiRISE Image: PSP_009650_1755
• The hummocky plains preserves sinuous ridges likely to be inverted channels.
• Chains of mesas extend from the wall to the mound.

HiRISE Image: PSP_009571_1755
The mesas appear to be associated with fans along the northern wall, and extend across the crater floor to merge with the mound-skirting unit at the base of the mound.

Anderson & Bell (2010)
- Are these features inverted channels or bedforms?
Science in the Ellipse: Inverted Features

• Cemented Fractures
  – How did the fractures form?
  – What is the composition and alteration history?

• Inverted channels
  – Determine depositional environment and flow characteristics.
  – Are the dense, branching features inverted channels or aeolian bedforms?

• Chains of mesas
  – What is their relation to fluvial processes?
  – Are they actually the same as the mound-skirting unit?
Science in the Ellipse: Old and Young Bedforms

- Study large “young” dunes - how active are they?
- Characterize lithified bedforms in the mound-skirting unit
The mound-skirting unit overlies the mound’s basal unit, forming scarps and mesas.
• This light-toned, fractured, layered material is a ridge that broadens to the northeast.

CTX: MSSS/JPL/NASA
• The trough between the light-toned ridge and the rest of the mound shows the strongest CRISM phyllosilicate signature in Gale. (Milliken et al. 2010)
- The rippled surface of the phyllosilicate-bearing trough appears to be hard: it is fractured, and dark dunes on it do not blend with their substrate.
• A filled channel is carved into the layered rocks of the lower mound.
• Channel fill material extends onto a patch of the mound-skirting unit.

HiRISE Image: PSP_009149_1750
• MSL would be able to access a distinct marker bed that is traceable around much of the mound.
• Erosion-resistant ridges are common in Gale, including on the mound near the MSL traverse.
• This area is the primary target for MSL
  – Study interbedded phyllosilicate and sulfate-bearing strata, including marker bed
  – Characterize channel fill and the outcrop of mound-skirting unit
  – Work upwards through the lower mound stratigraphy
  – Study erosion-resistant fractures
• Left: Two possible traverses starting at the center of the ellipse.

• Traverse 1 is preferred: mound strata are better-exposed.

• Traverse 2 comes closer to inverted channels in the ellipse and spends more time on the mound-skirting unit.
Conclusions

• Science targets in the ellipse:
  – Alluvial fan with exposed stratigraphy
    • Determine frequency and nature of deposition
    • Sample noachian crust
    • Study examples of subsequent burial and erosion
  – Inverted channels (on and off the fan)
    • Determine depositional environment, flow characteristics and duration
  – Cemented fractures
    • Characterize their composition and alteration history
  – Mound-skirting unit
    • Investigate relationship with fluvial processes (chains of mesas) and aeolian processes (lithified bedforms)
  – “Young” mafic dunes
    • Characterize modern aeolian transport parameters, soil mechanics, induration rates, etc.

• These are all targets of opportunity that MSL could study on the way to the mound.
Conclusions

- Science targets on the mound:
  - Basal unit and light-toned ridge
    - Determine composition, depositional setting, etc.
  - Interbedded phyllosilicates and sulfates
    - Alteration and depositional environment
    - Biomarker preservation
    - Do these reflect a global change?
  - Filled channel and fan-shaped outcrop of mound-skirting unit
    - Channel fill may provide samples from higher on the mound
    - Outcrop places the mound-skirting unit into stratigraphic context
  - Large cemented fractures
    - Characterize the post-depositional alteration of mound materials
  - Kilometers of stratigraphy!
    - Construct a detailed picture of ancient Mars.

- Gale Crater is a diverse landing site, with many science targets inside and outside of the ellipse!
  - MSL would be able to access materials from many different environments, maximizing knowledge gained about martian habitability.