Aqueous Alteration and Habitability in Nili Fossae


A transect across critical periods of martian history
Sampling and characterizing
Impact ejecta
Hesperian volcanics
Phyllosilicate bearing infill of Nili Fossae
Strongly altered Noachian crust
Unaltered Noachian crust

Noachian crust enriched in low-Ca pyroxene
Noachian crust enriched in phyllosilicate
Nili Fossae Trough

- Noachian is the most important period of habitability
  - Smectite clay mineral formation
  - Capturing, sequestering and preserving organic material and bio signatures

- Intact Noachian stratigraphy
  - Strongly enriched, DIVERSE phyllosilicate
  - Alteration processes: surface, shallow crust, hydrothermal, lacustrine (testable hypothesis)
  - Unaltered basement in contact with phyllosilicate => chemical disequilibrium

- Cross the Noachian-Hesperian boundary
- Hesperian volcanics of Syrtis Major sample a critical time-stratigraphic marker and major planetary lithology
Nili Fossae Trough

• Crustal Formation
• Isidis Basin Formation
• Nili Fossae trough develops
• Dissection and erosion of Nili Fossae walls by processes that include fluvial (formation of layered-bedded units)
• Infilling of Nili Fossae trough,
• Syrtis Major lavas pave the floor of the trough
• Emplacement of ejecta from 65 km diameter crater
Noachian Crust: Extraordinary mineral diversity

Ehlmann et al., 2007
Mineralogy identified
Crystalline hematite
Fe/Mg Smectite
Kaolinite
Pyroxene (Low and High Ca)
Olivine
FRT000064D9: 2.4, 1.8, 1.15 µm RGB
Unaltered basement enriched in low-Ca pyroxene as capping unit and on the floor

Thick section of phyllosilicate-rich Noachian basement exposed in Fossae walls

Phyllosilicate-bearing basement beneath volcanics

Syrtis Major Volcanics
Low-Ca Pyroxene
Phyllosilicate
Fe-Phyllosilicate

Unaltered Noachian crust embedded in phyllosilicate-bearing formation
Layered Sediments
LCP-rich Noachian Crust
Smectite-rich Noachian Crust
Smectite-bearing Fossae Fill
Syrtis Lava Hesperian
Phase 1
3.9 km
5.8 km
Phase 2
Ejecta
Syrtis major flows
Hesperian-Noachian Boundary
10 km
Safety

• Latitude: 20°N
• Topography: -690 to -520 m
• Rock Abundance: Tbd
• Slopes: OK...
• Thermal inertia: OK
• Albedo: OK
Nili Fossae Trough

• **Ellipse Science:**
  – Sample a major igneous and time-stratigraphic unit for Mars
  – Characterize well preserved, phyllosilicate-bearing eject deposits of a 65 km diameter impact crater
  – Traverse the Hesperian-Noachian boundary
  – Characterize Nili Fossae fill and phyllosilicate sediments

• **Monument Valley Science:**
  – Mineralogy, geochemistry, and stratigraphy of Noachian crust highly enriched in phyllosilicate
  – Characterize mineralogic diversity as seen from orbit and assess hypotheses for alteration ==> Noachian habitability
  – Sample unaltered, in situ Noachian crust
  – Access alteration fronts
Nili Fossae Trough

• Ability to assess biological potential with MSL Payload
  – Full suite of the MSL payload will be essential to understand site
  – Includes crustal formation, igneous processes, alteration processes and crustal, near surface, and surface environments
• Evidence for habitably environment
  – Mineralogy, geochemistry, and stratigraphy of Noachian crust highly enriched in phyllosilicate
  – DIVERSE phyllosilicates suggest a range of water-rich environments with gradients in energy, T, P including sedimentary
• Preservation of biosignatures
  – Abundant smectite clay ideal for capturing and preserving organics
  – Access unaltered, in situ Noachian crust in contact with alteration
• Ability to characterize geologic setting
  – Important stratigraphic transitions in the landing ellipse
  – Clear stratigraphy including Noachian units