# Post- Early Mars local aqueous environments in Noctis Labyrinthus Chasmata

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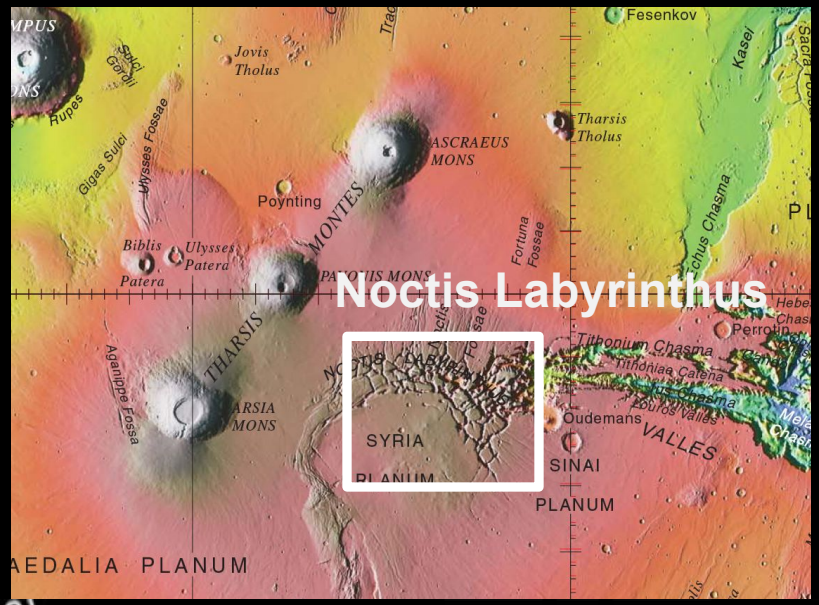
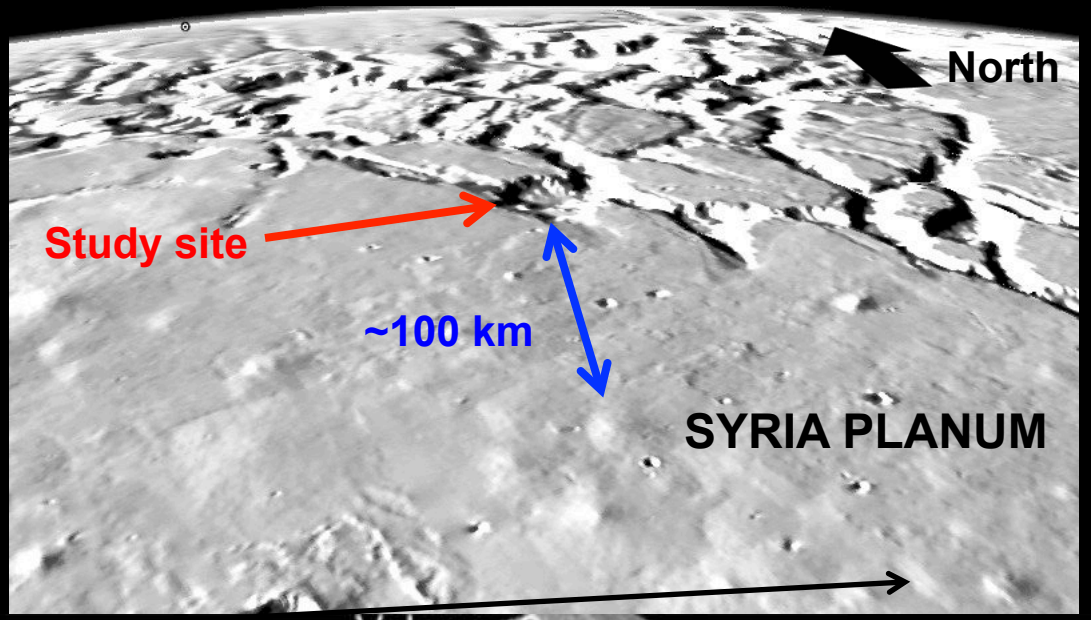
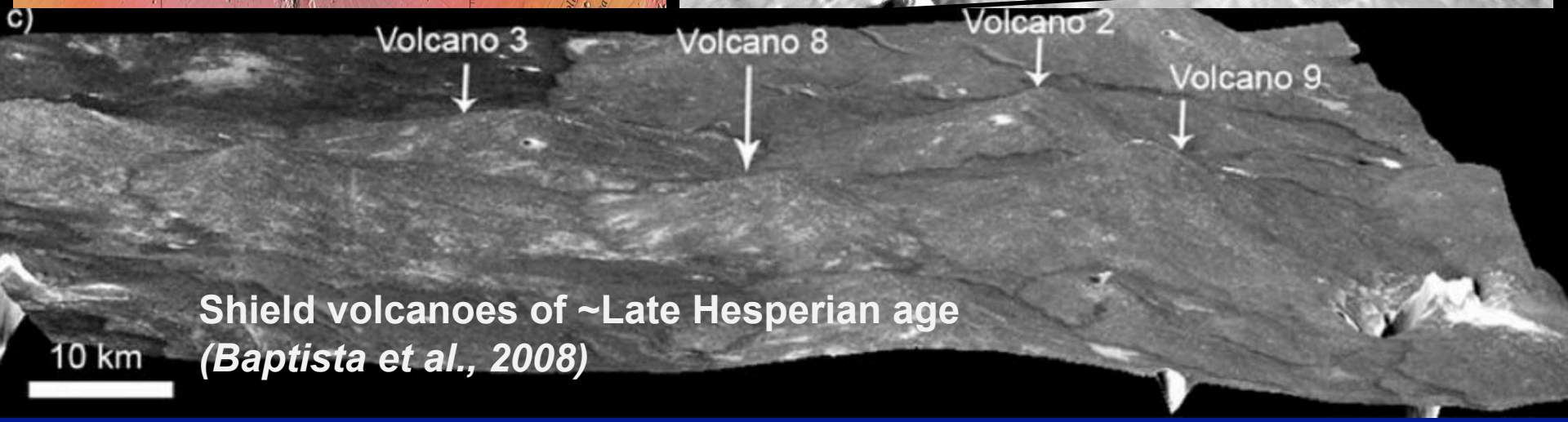
# Context

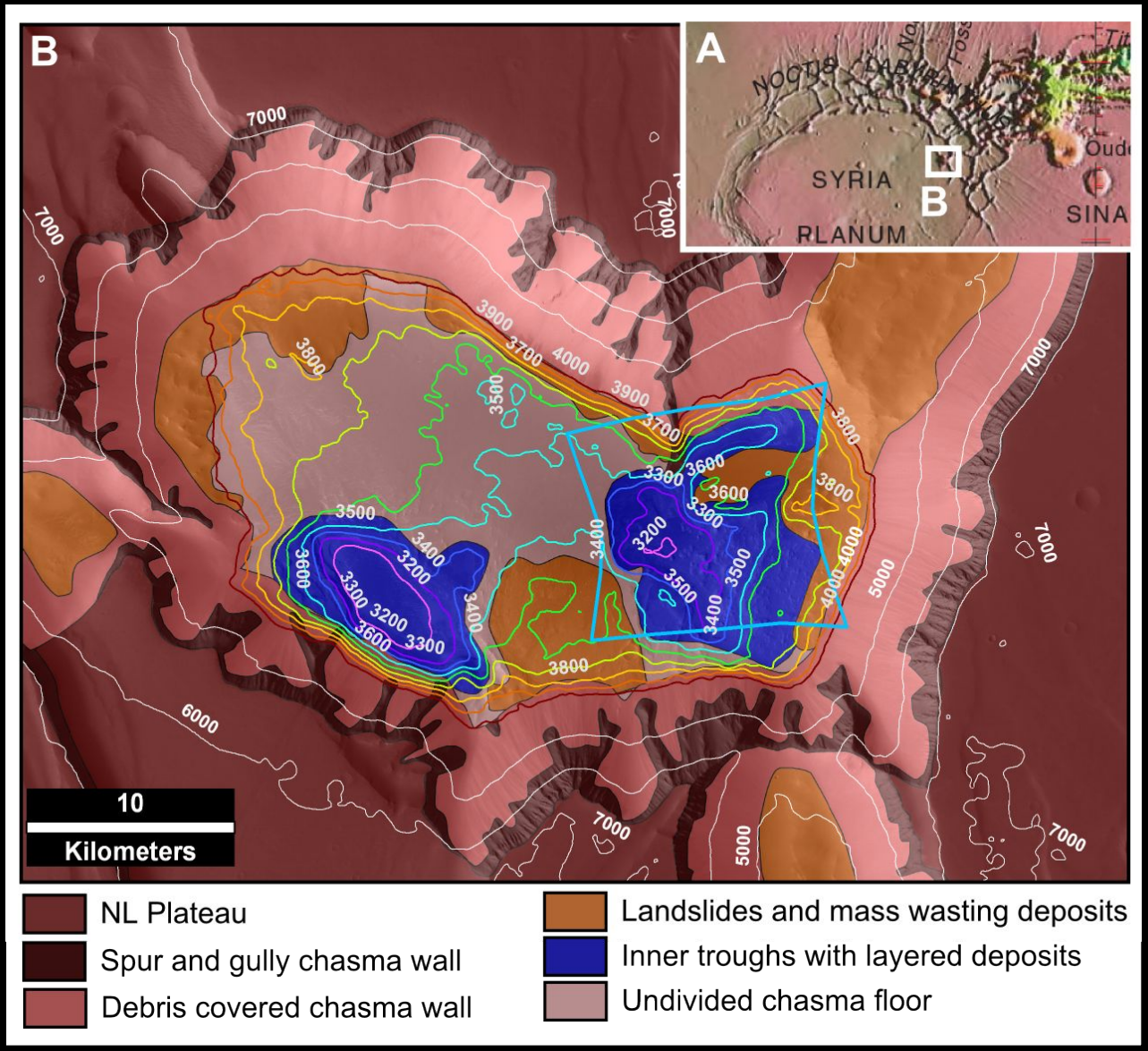
A site of **exceptionnal** mineralogical diversity, close to **volcanic** constructs



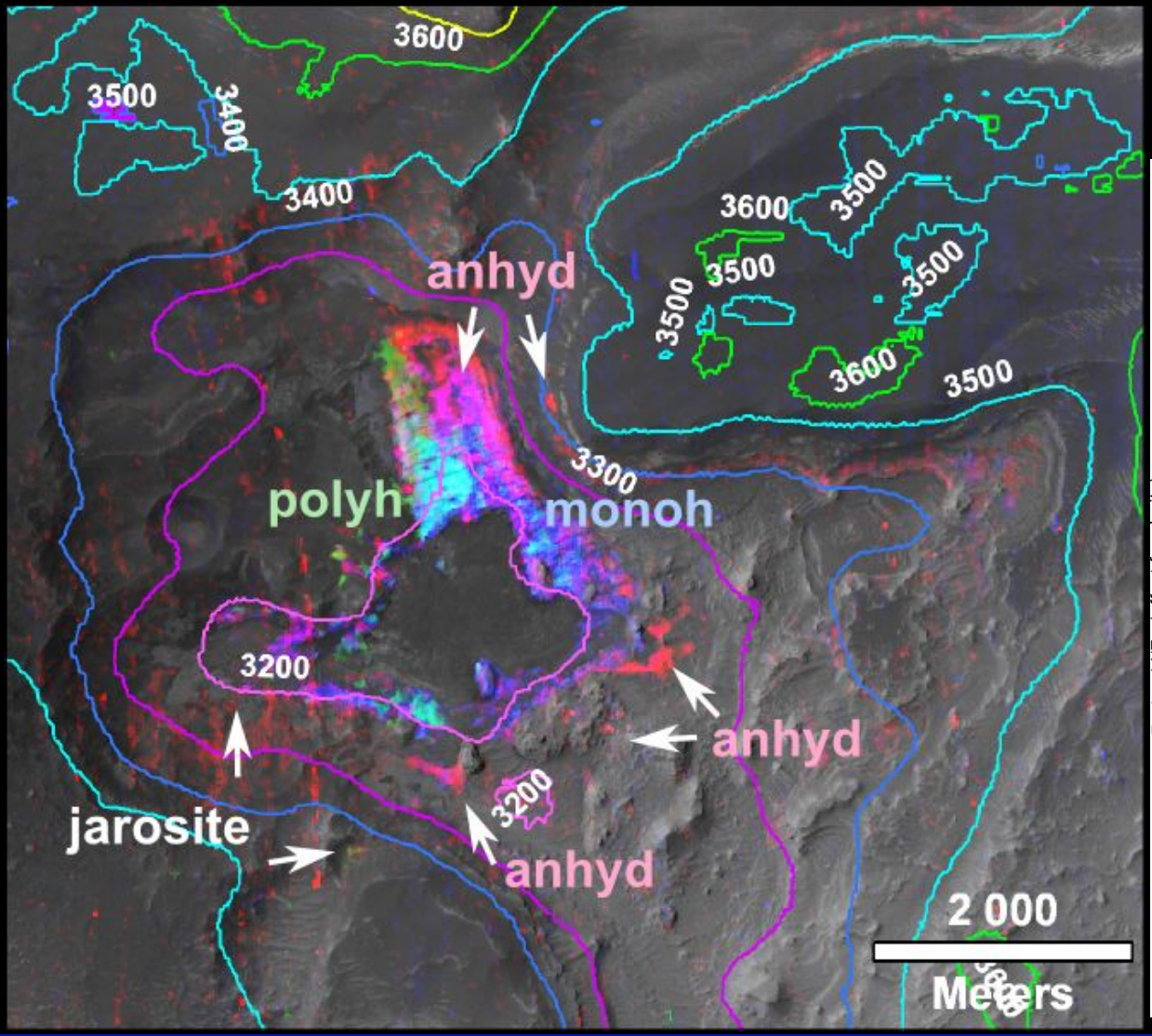
# Context of the studied chasma

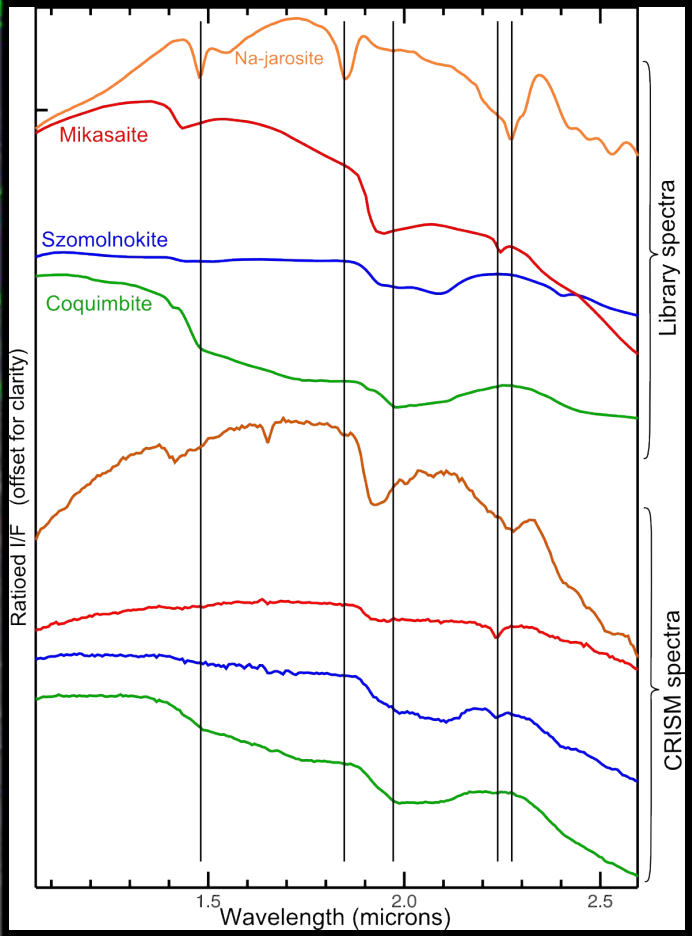



- 3-4 km elevation gradient
- Landslides
- 2 depressions or « inner troughs » with layered deposits
- LOCALIZED layered deposits
- NO morphologies suggestive of transport of material to the chasma: local alteration
- CRISM data

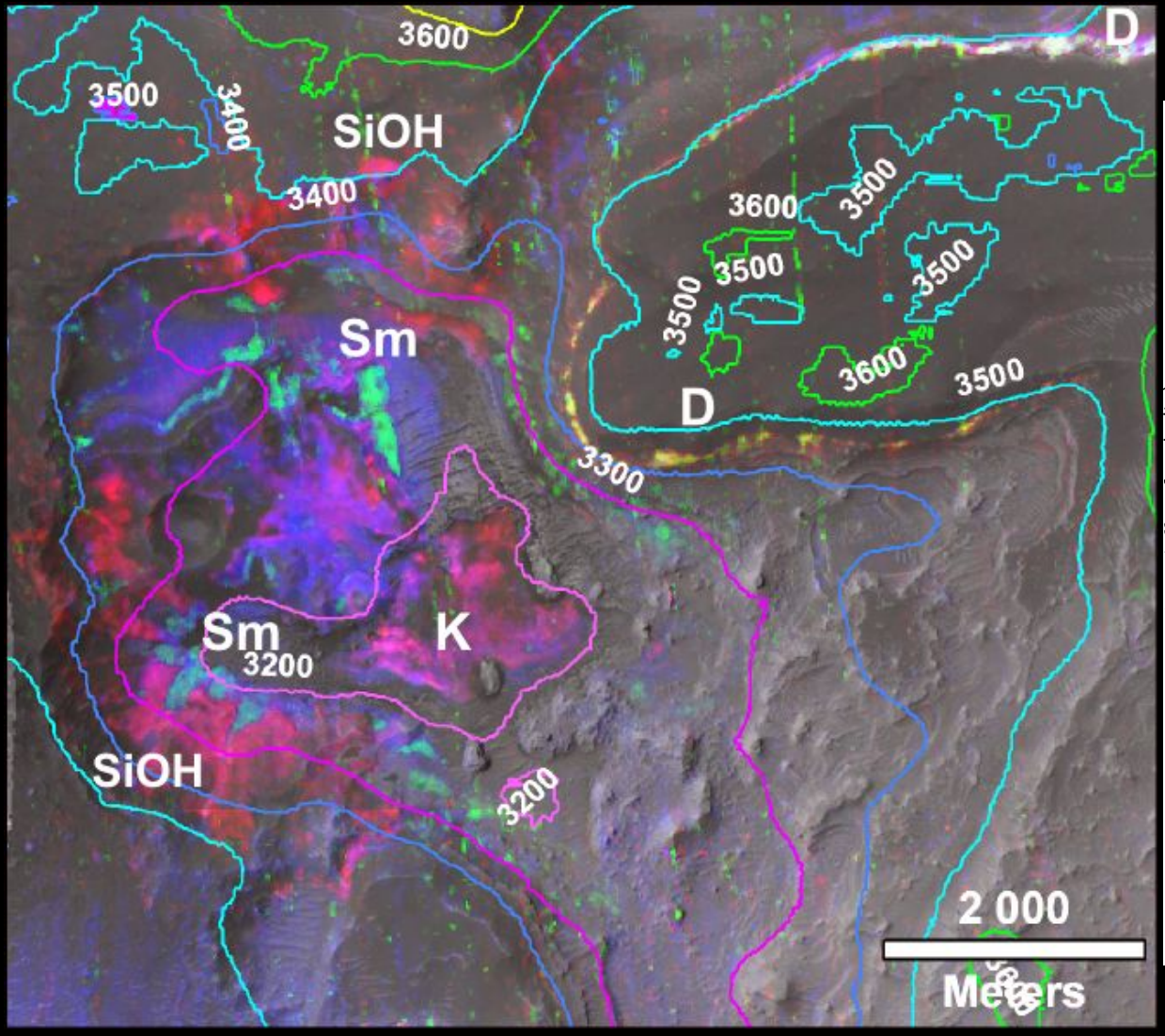
# Mineralogical diversity (1/2)
# Fe-sulfates

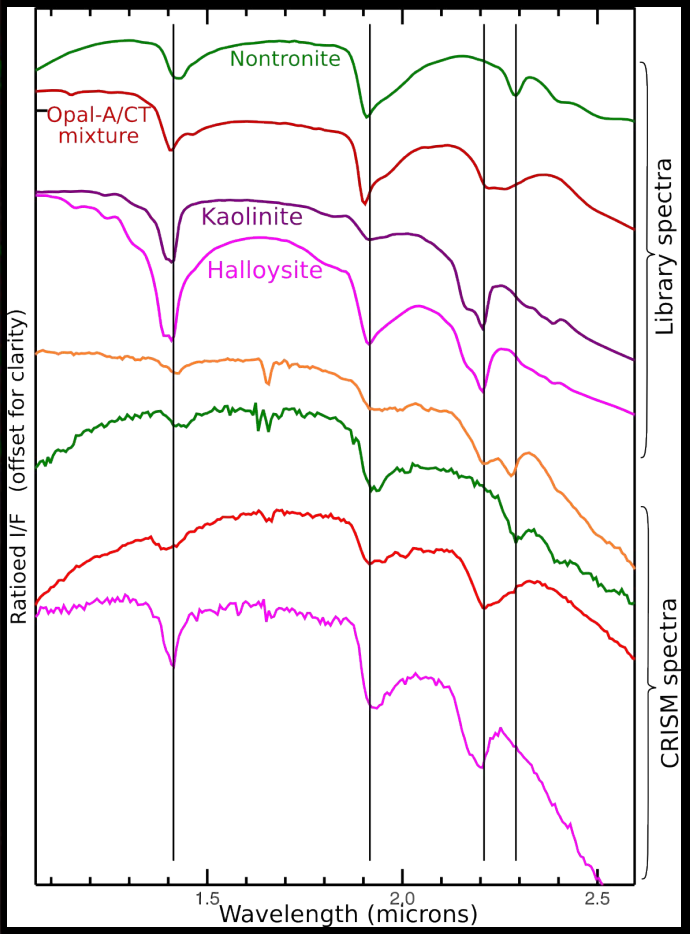
Jarosite $(K,Na)Fe^{3+}_3(SO_4)_2(OH)_6$
Mikasaite $Fe^{3+}_2(SO_4)_3$
Szomolnokite $Fe^{2+}SO_4.H_2O$
Coquimbite $Fe^{3+}_{2-x}Al_x(SO_4)_3.9H_2O$



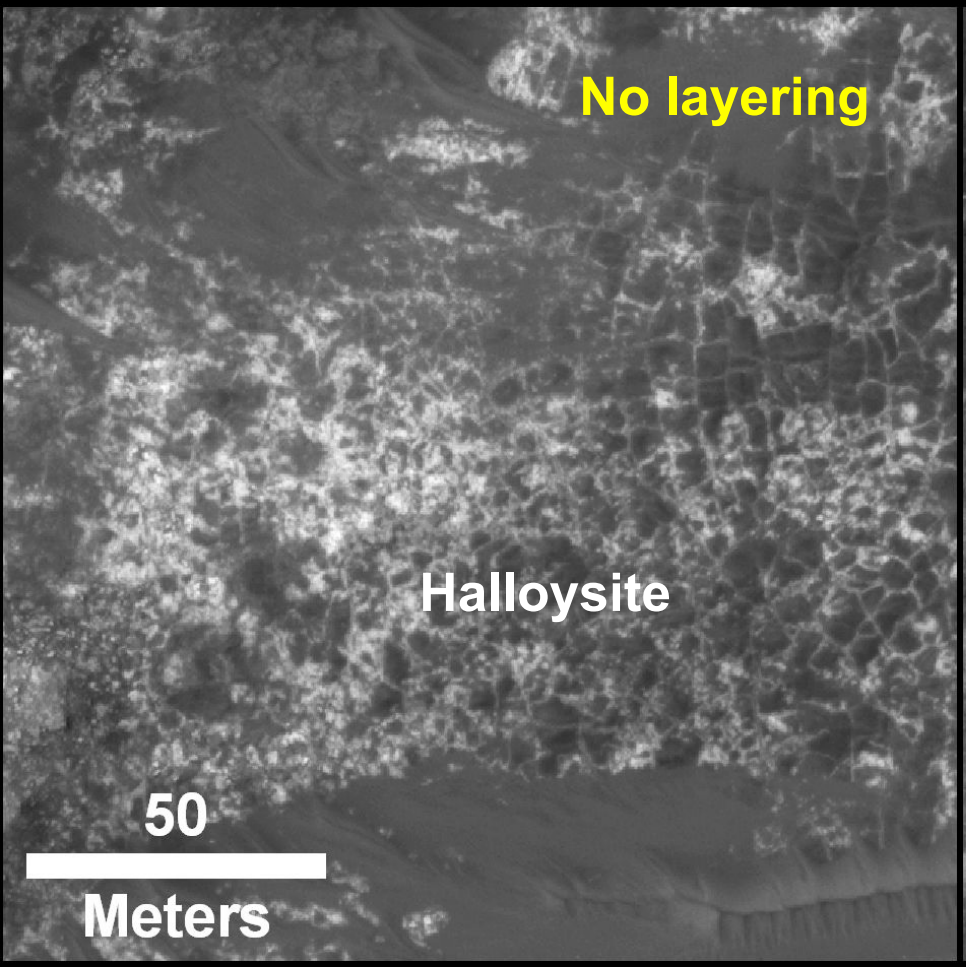



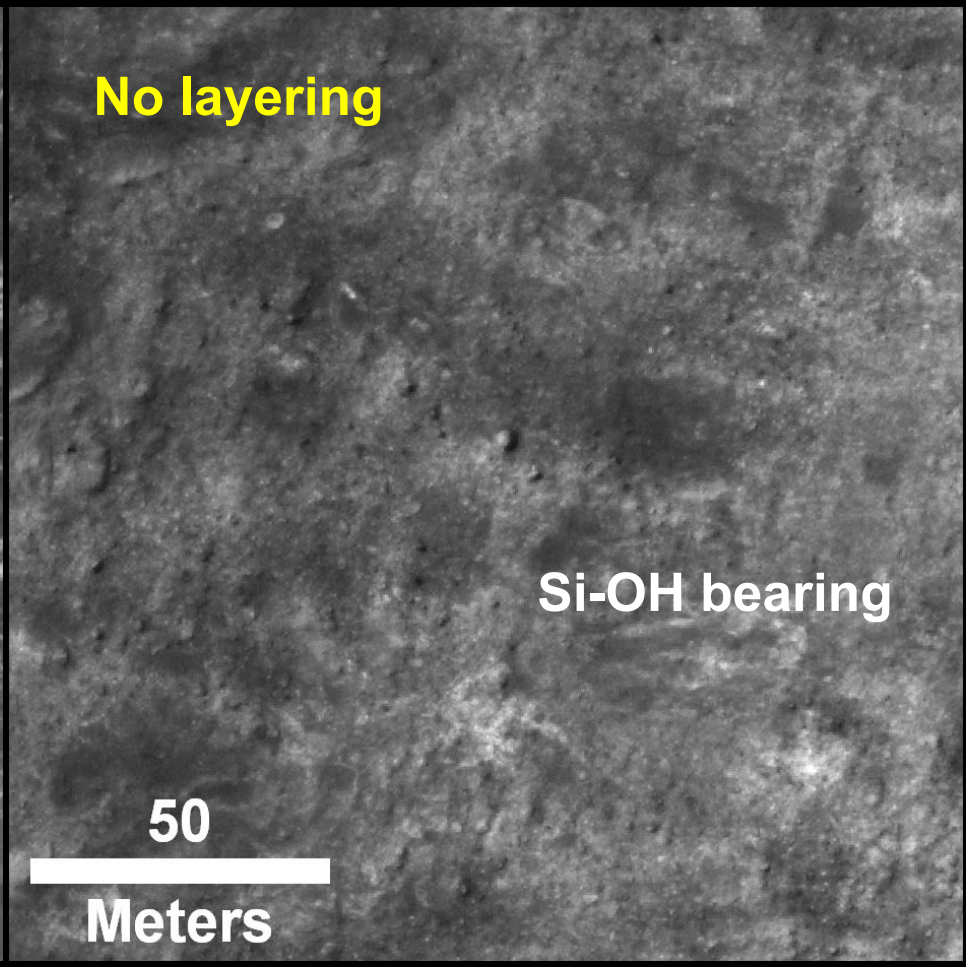
# Mineralogical diversity (2/2)
# Clay minerals, etc.



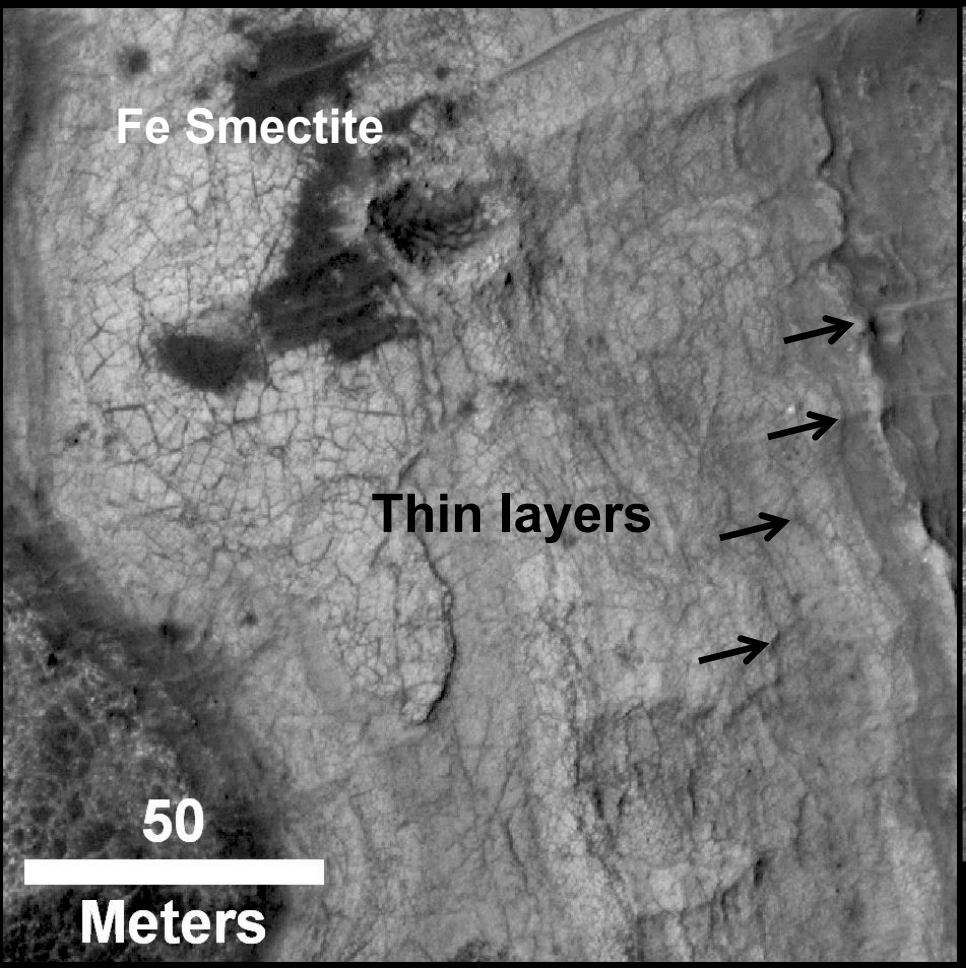
# **Spectral** units correlate to **morphological** units

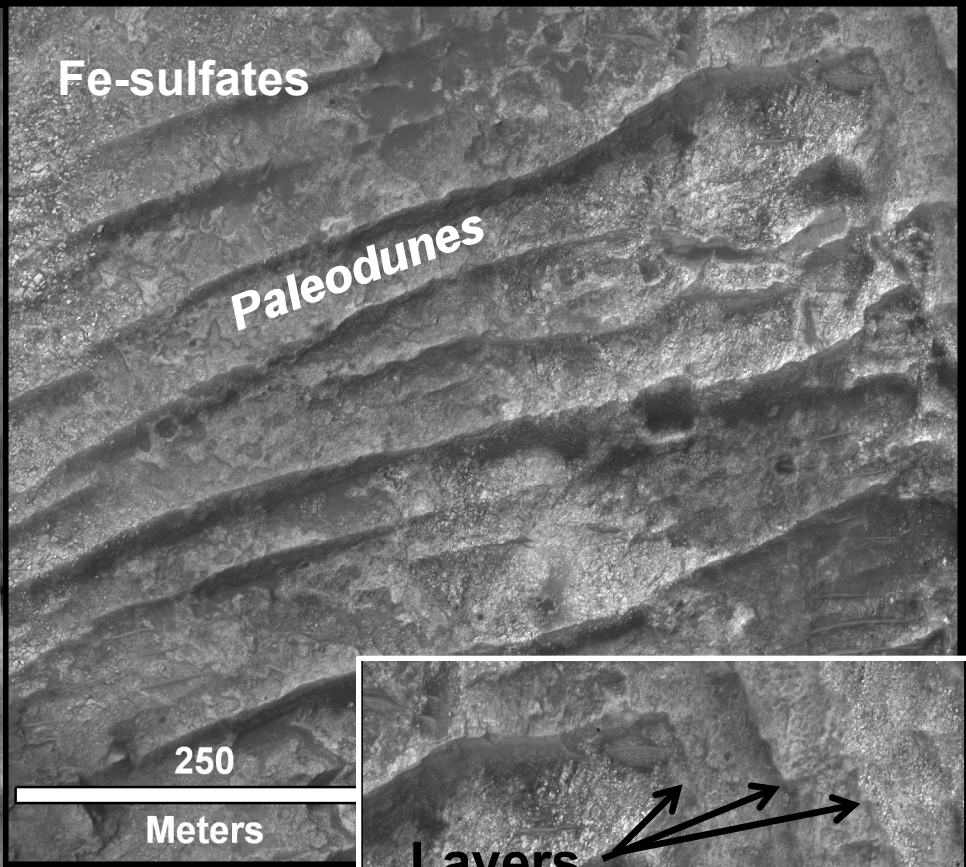


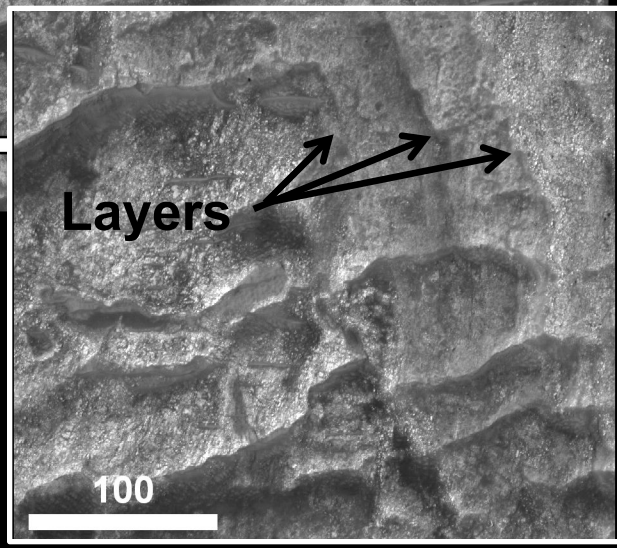




Bedrock

# **Spectral** units correlate to **morphological** units

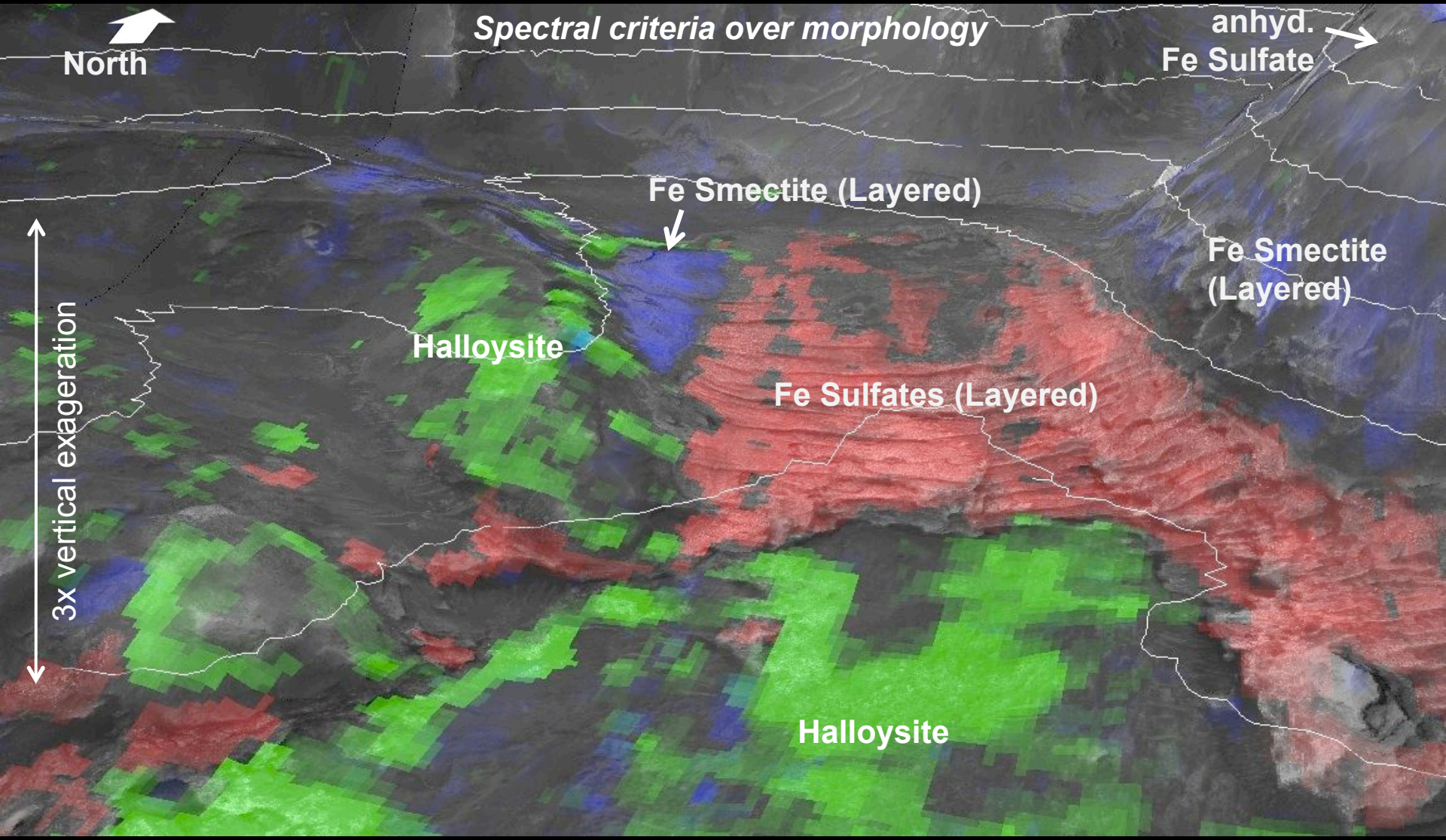



Layered deposits

# Draping of layered deposits



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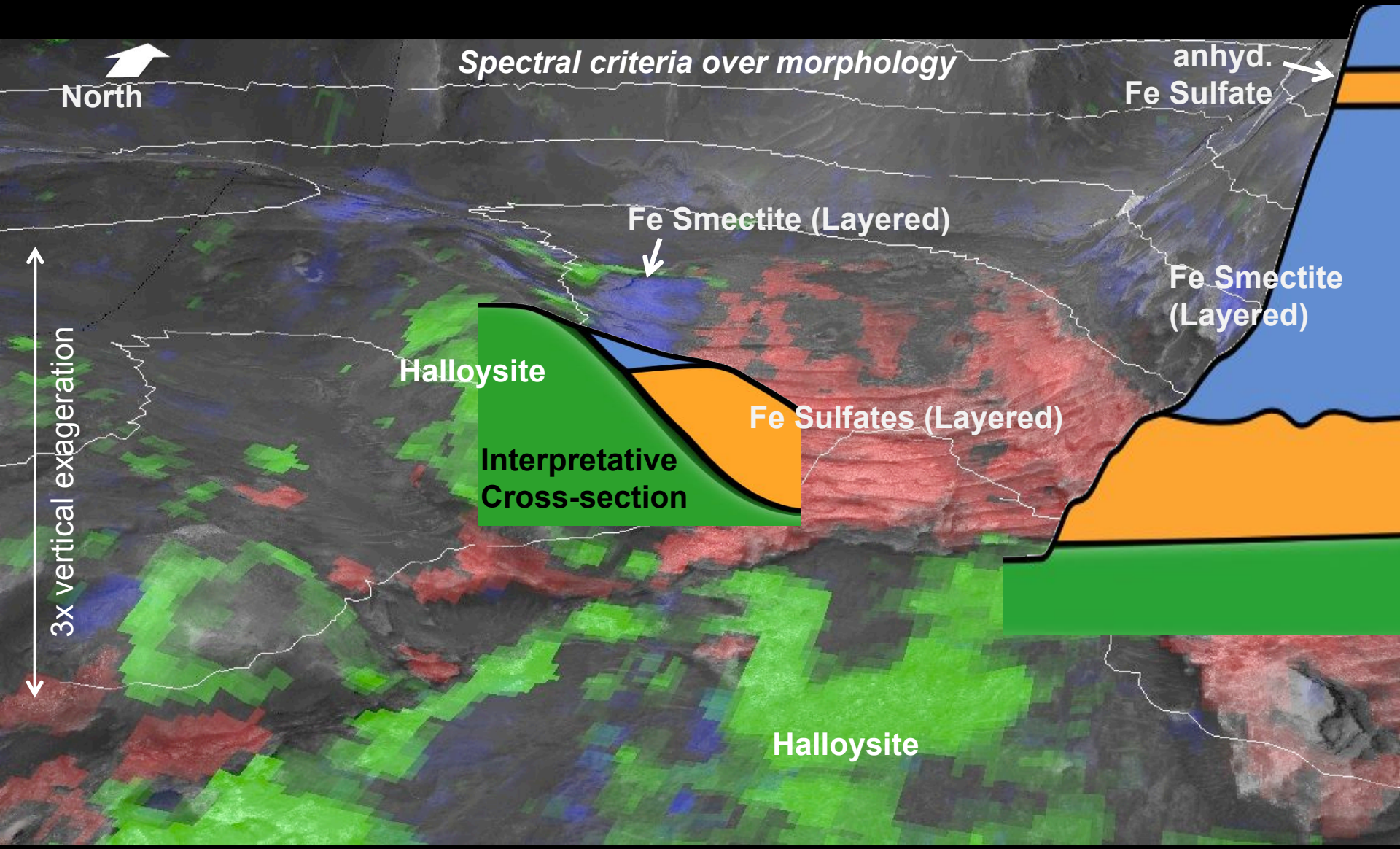
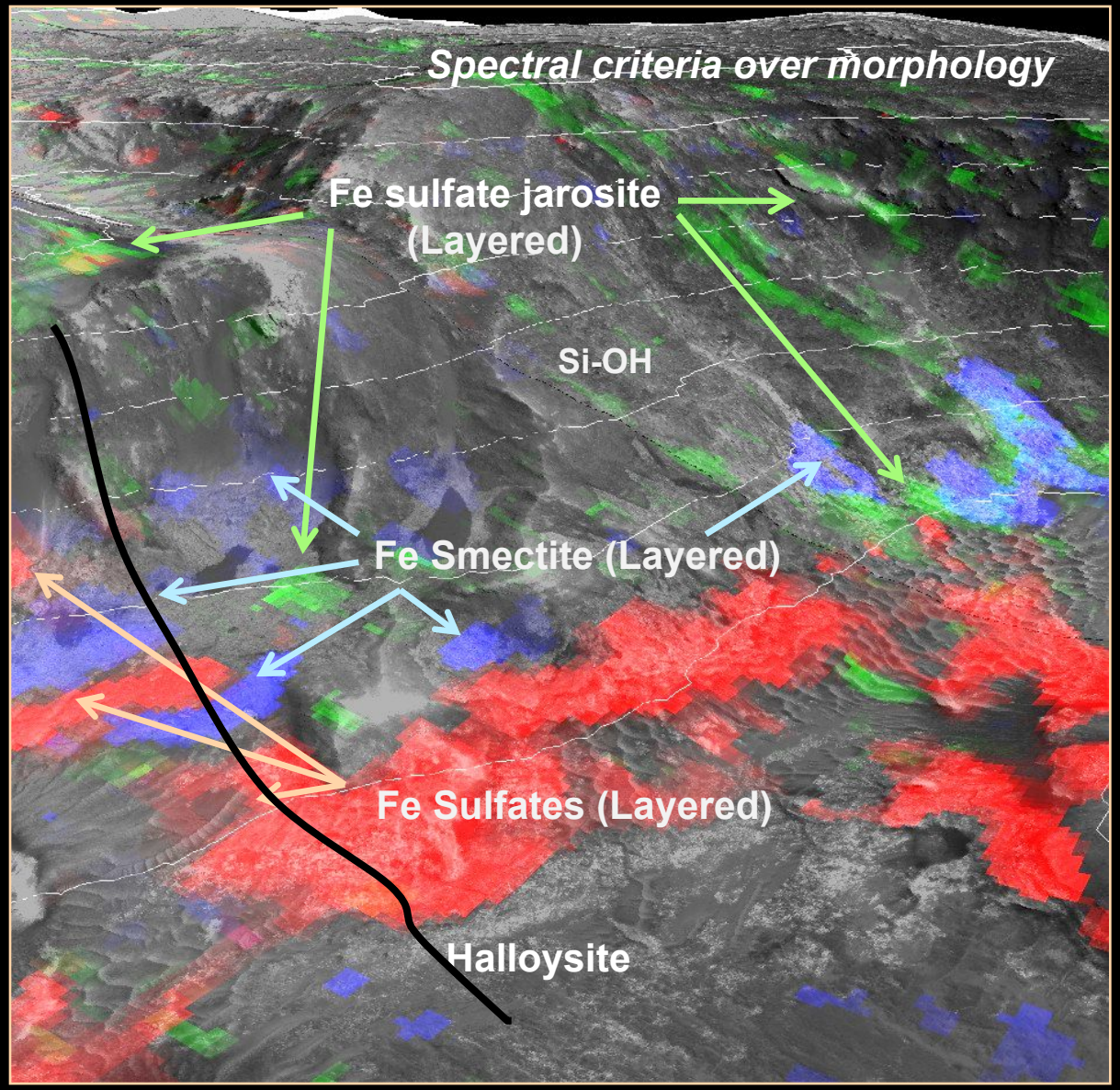
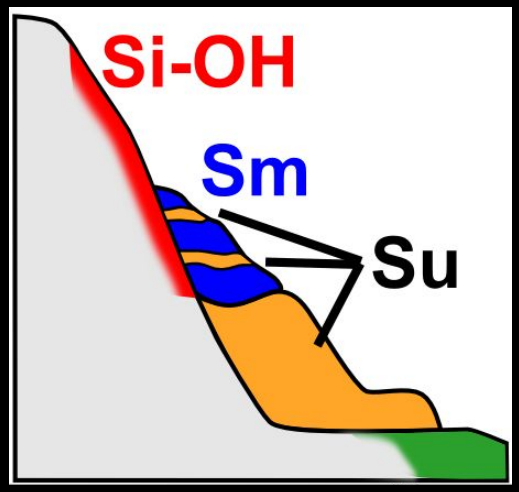


# Interbedding of Fe sulfates & smectites



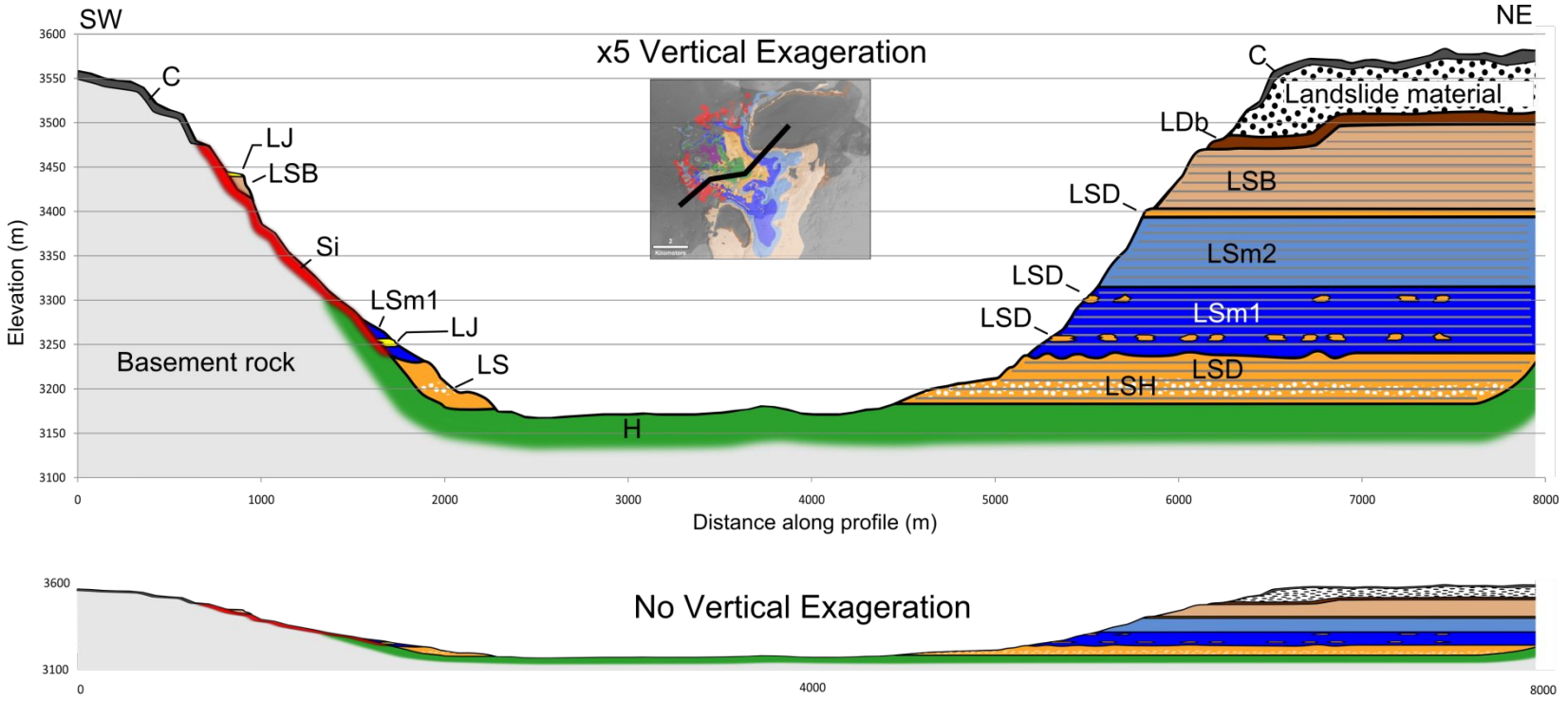

3x vertical exageration

North




Interpretative cross-section

# Obs. summary: inner-trough cross-section




- Current inner trough cutting through layered deposits
- Layered deposits draping a « proto » inner trough in the bedrock

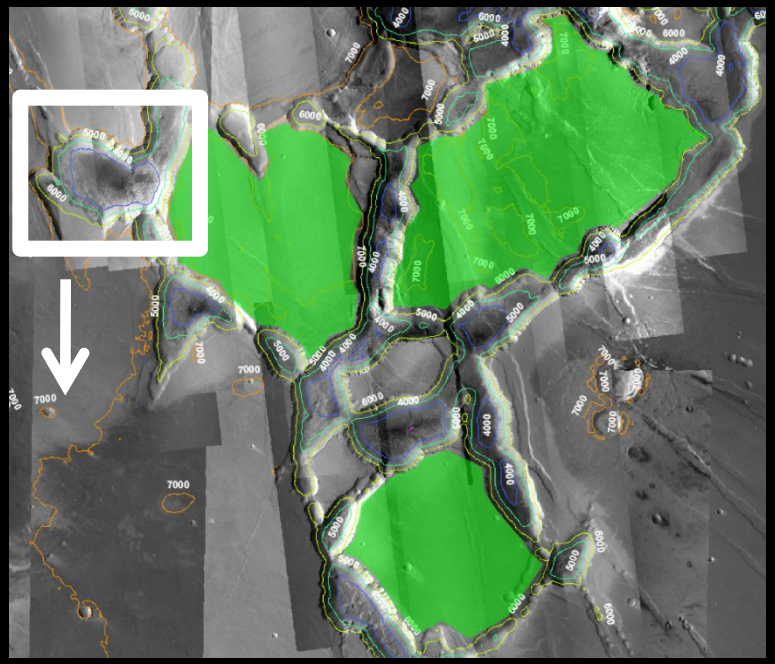
Layered deposits emplaced, altered, cemented **after** chasma formation

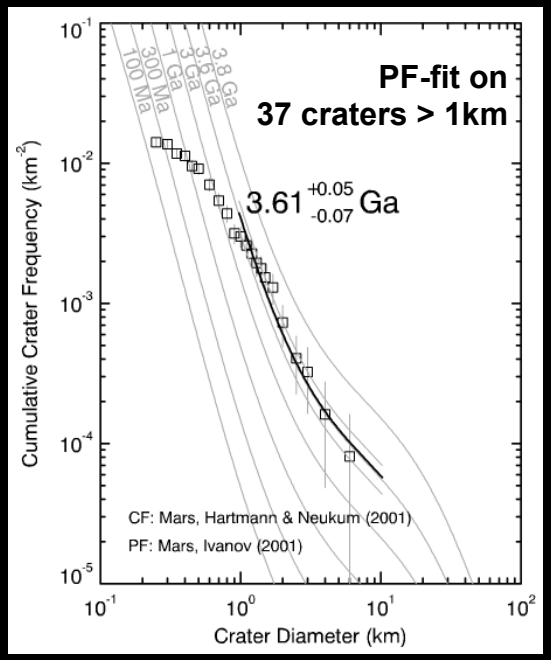
# Chrono-logy

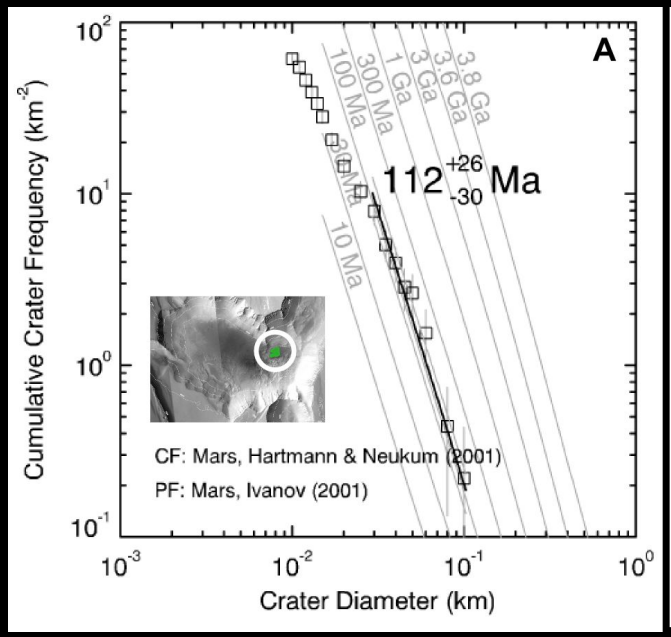
**Late Hesperian Plateau:**
**~3.6 Ga**

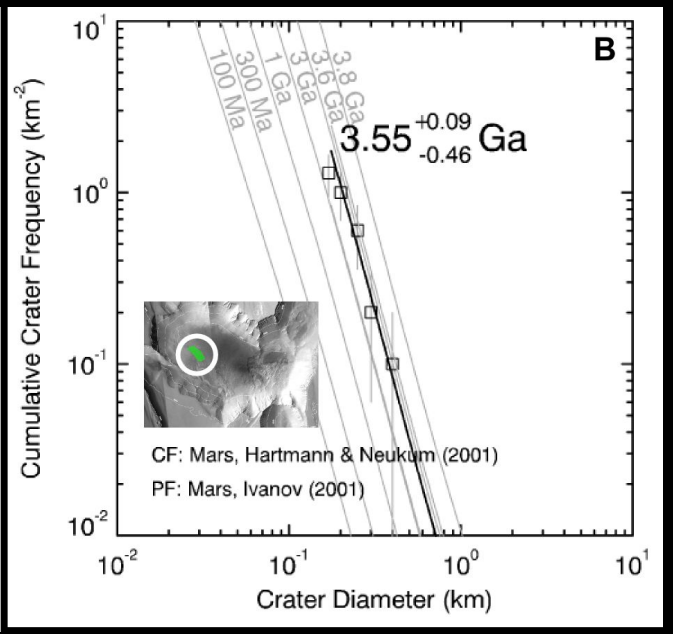
**Chasma floor : areas as old as**
**~3-3.6 Ga**

**Capping unit**
**~100 Ma**



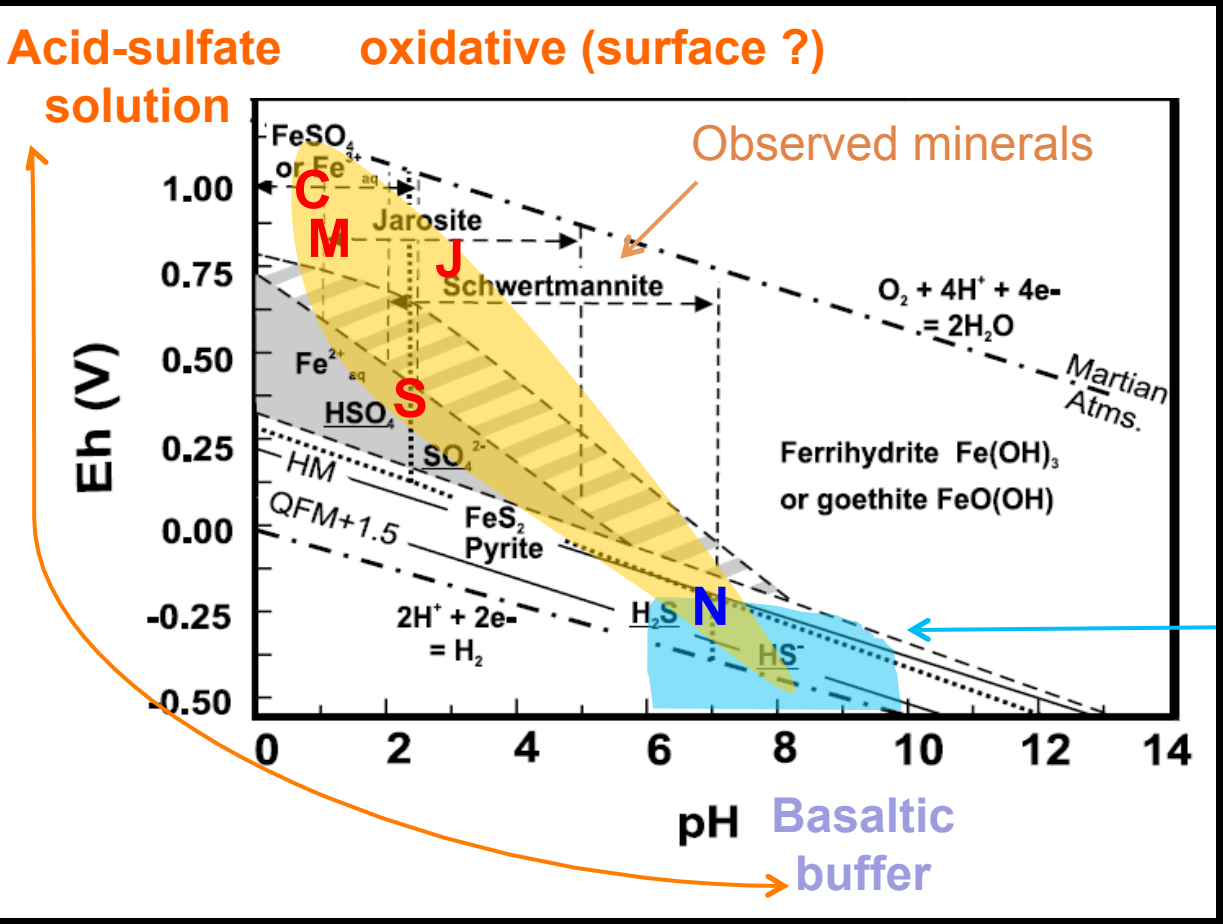


# Some geochemical constraints

## Fe-smectite vs. Fe-sulfates vs. Fe oxi/hydroxides ?




Ranges of phase stabilities of Fe sulfates and Fe oxi/hydroxides (King & McSween, 2005)

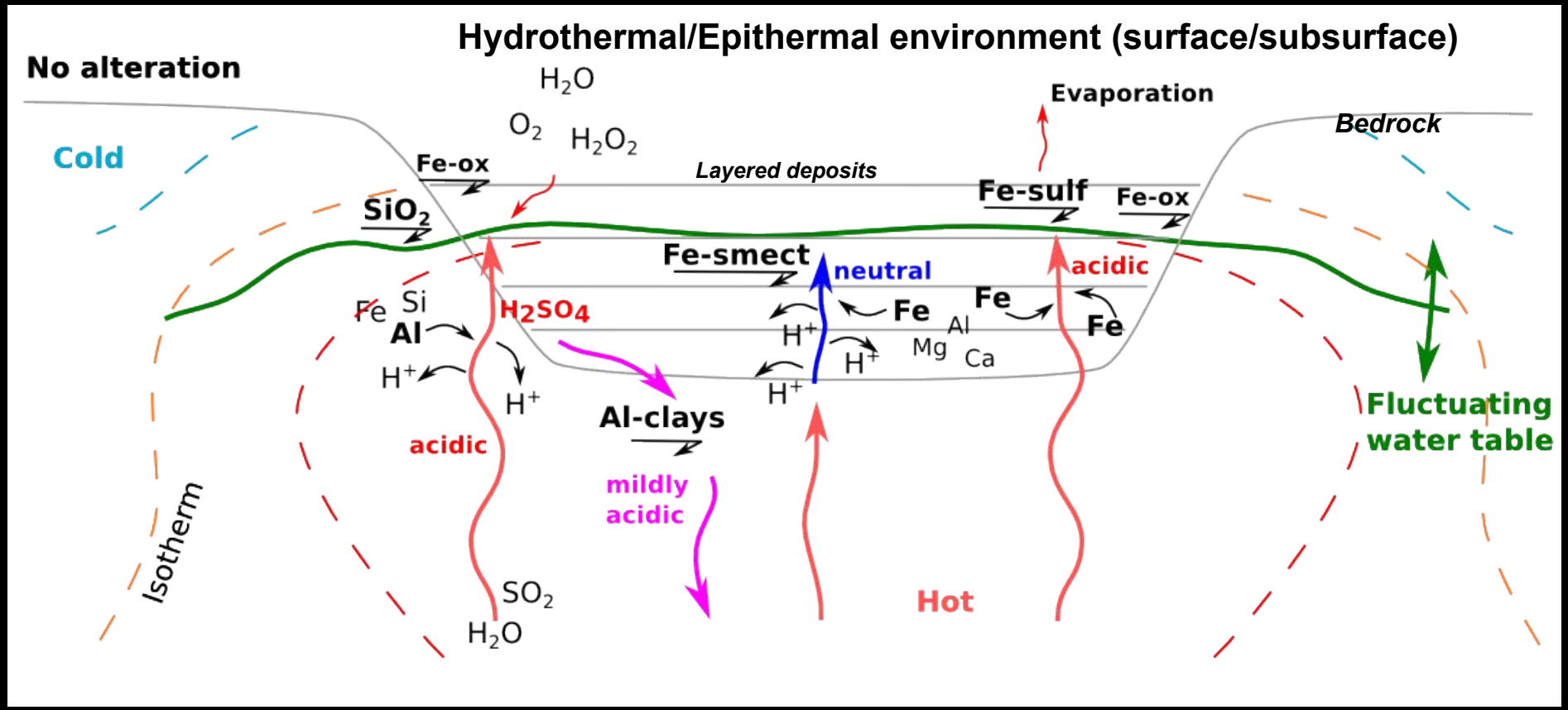
Fe-smectite formation field (Harder, 1976)

**Low pH, high sulfate:** **Ferric/Ferrous sulfates – f(Eh)**
**Low/Neutral pH, low sulfate:** **Fe oxi/hydroxides (high Eh)**
**Neutral pH, low sulfate:** **Fe smectite (low Eh)**

# Hypothetical formation processes

Primary material: Basaltic bedrock & repeated deposition of basaltic tephra layers (volcanic activity). Possibly **heterogeneous** composition.

**Authigenic** alteration minerals



# Conclusion

- Associated phyllosilicates + sulfates + hydrated silica
- Post Noachian/Phyllosian phyllosilicates
- Local processes from volcanic activity & hydrothermalism :
  - Acid-sulfate alteration: Fe leaching and Fe-sulfates precipitates
  - Local buffering by water-rock interaction: clays

- A localized environment can generate most mineral classes observed anywhere on Mars (silica, clays, sulfates, oxi/hydroxides)

- Post « early Mars » environment with liquid water and variable Eh and pH conditions, suitable for biochemical reactions