Deposition of Interior Layer Deposits within East and West Candor as well as Ophir chasms, Valles Marineris, Mars

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Interior Layered Deposits in Valles Marineris

- Most consider them early basin fill, Hesperian deposits
- Estimated that ILDs cover 17% of the total area, representing 60% by volume of all deposits within Valles Marineris.

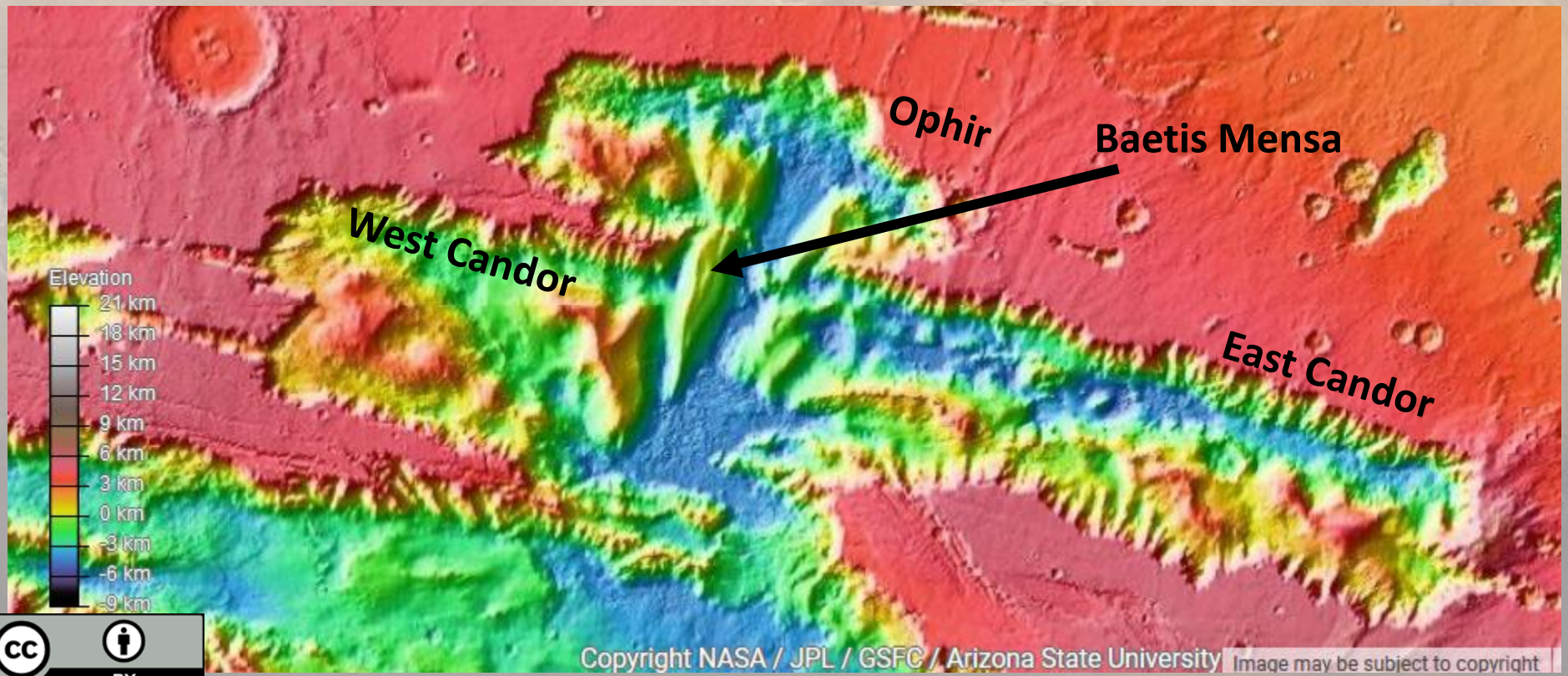
  Lucchitta et al. (1994), J. Geophys. Res., 99, E2, 3783-3798.
- Enigmatic, up to 8 km high deposits
- Multiple formation models

  See background in e.g. Fueten et al., 2017. doi: 10.1002/2017JE005334
- Significant volumes of poly- and monohydrated sulfates

  See e.g. Flahaut et al., 2010. doi:10.1029/2009JE003566,
- Understanding ILDs important information on the nature of the environment and on changes in the environment throughout time

Why East and West Candor and Ophir?

- Three major central chasms
- Considered ancestral basins
- All linked. Baetis Mensa straddles the wall between Ophir and Candor



Purpose

- To produce consistent map of three chasms using the same units
- Establish and compare stratigraphy in each chasm
- Document contact relationships between units
- Ultimately to have a better understanding of how basins filled

Methodology - Data

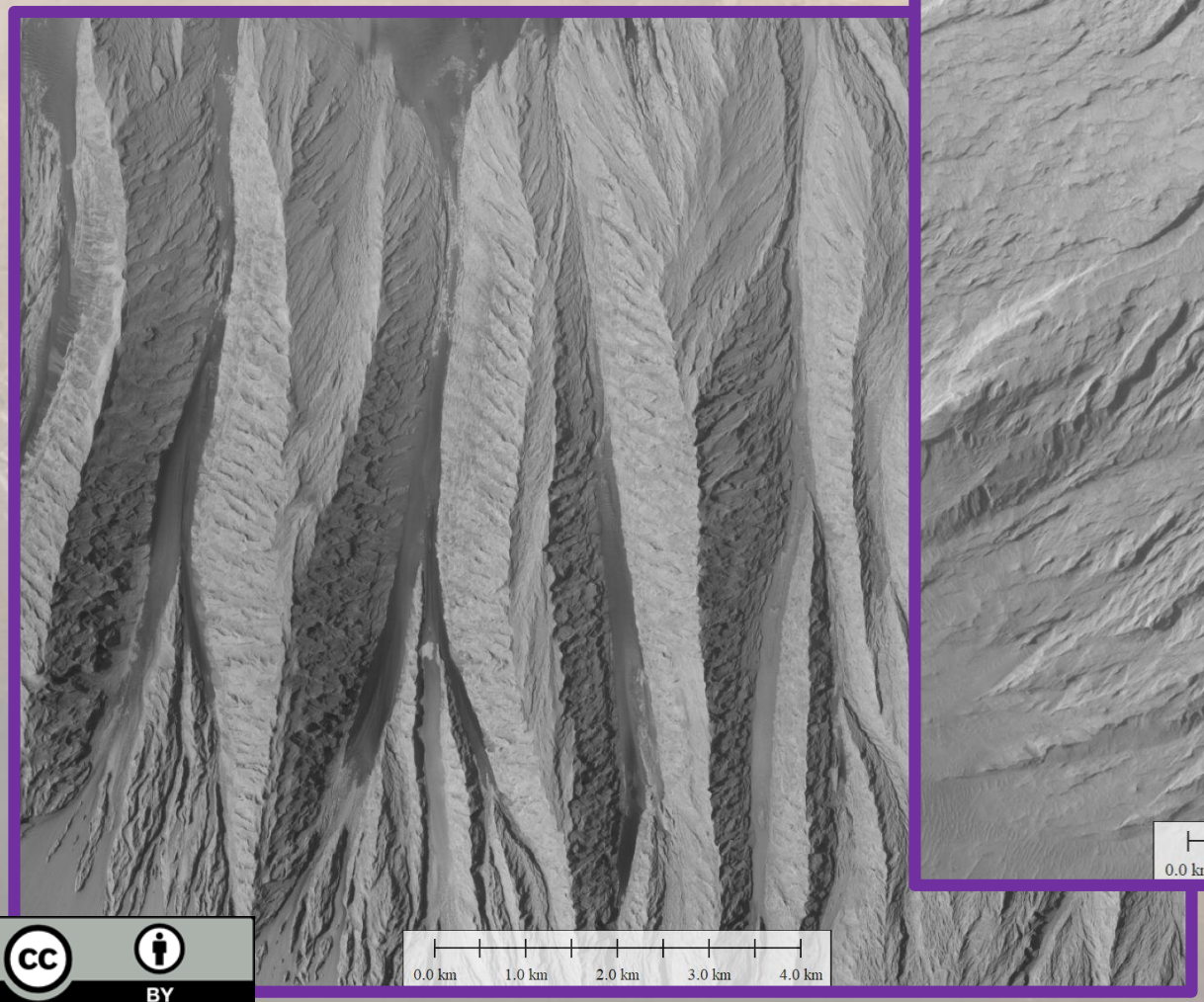
- CTX base maps – highest resolution full coverage
- All available HiRISE images examined for contacts and unit relationships.
- Contacts continued in CTX imagery to produce full map coverage of ILDs
- HRSC DTM – Best DTM for full coverage

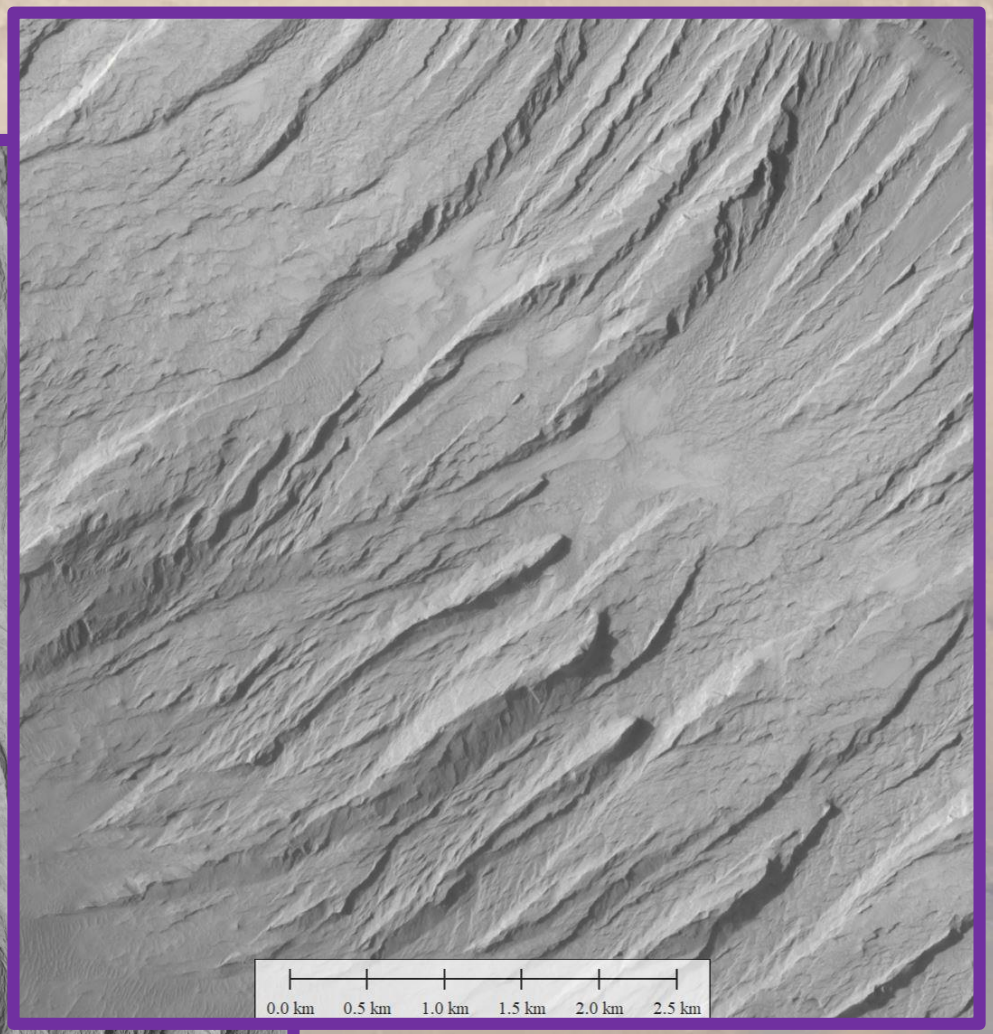
Methodology – Unit identification

- Unit identification primarily based on nature of layering in CTX imagery
- Required because CTX is the highest resolution imagery that offers full coverage of the area
- Simplified by use of only 5 main categories that can be recognized consistently in all chasm
- Some limitations of this will be discussed below

Units: Massive (HiRISE only layering)

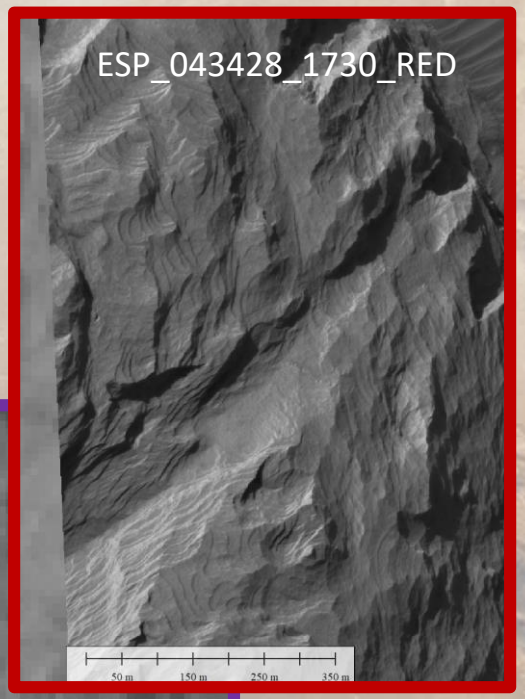
- light toned, no visible layering (in CTX)
- fluted erosional appearance on mounds

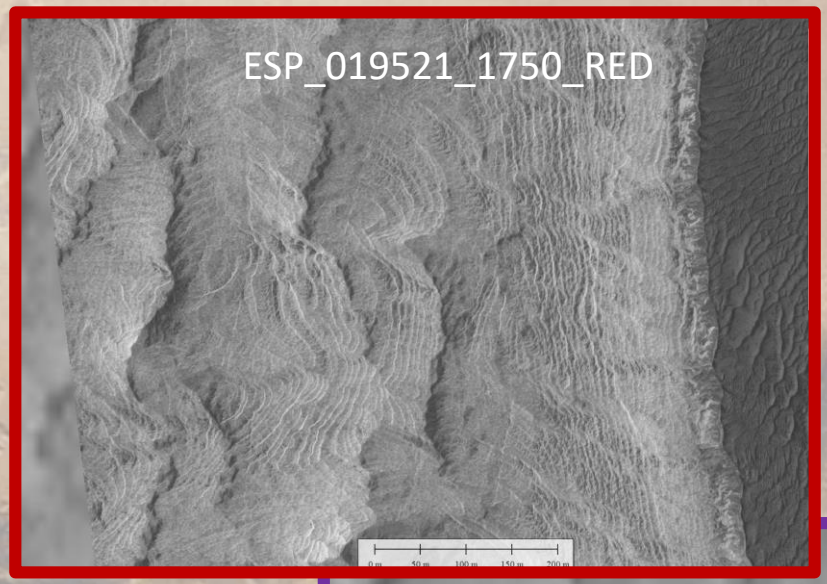


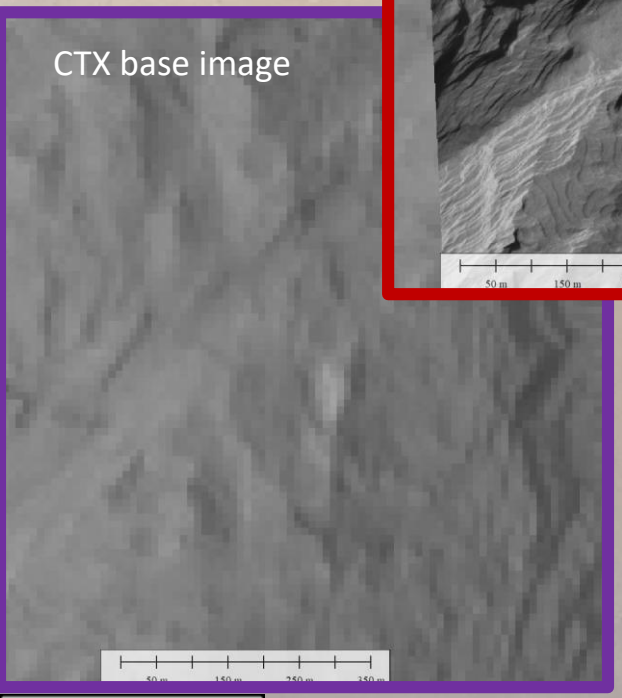


Units: Massive (**HiRISE only layering**)

- Does exhibit layering in **some, but not all** HiRISE images.







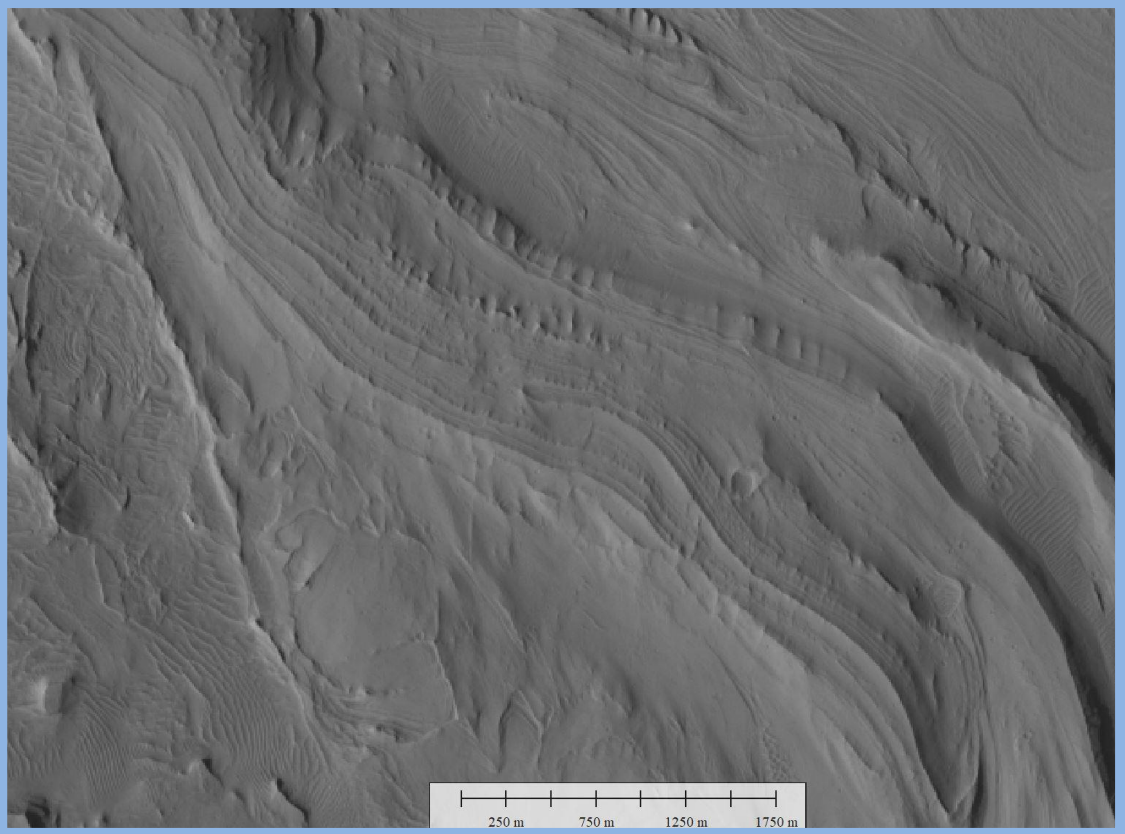
Examples:

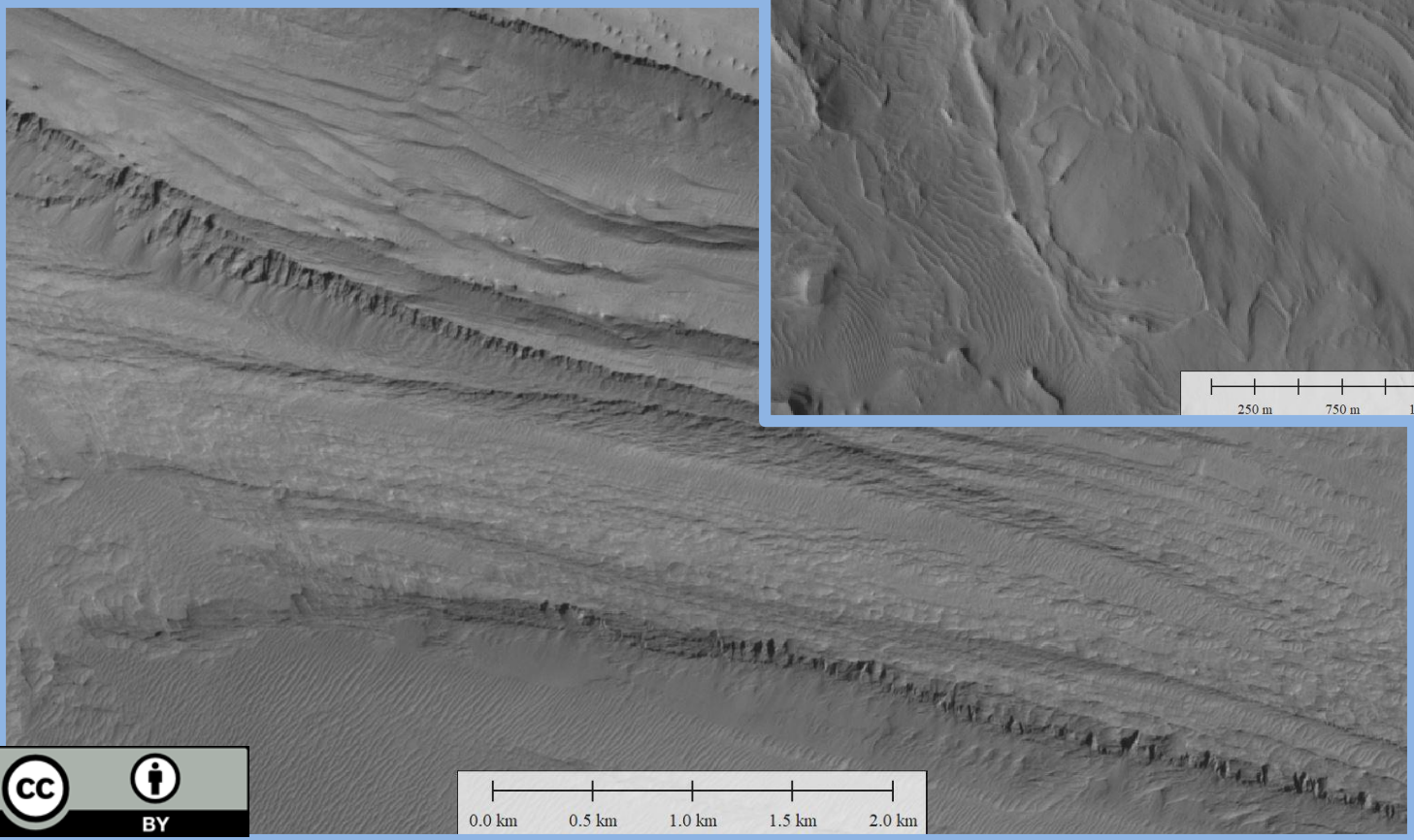
<-- East Candor

Ophir -->

Units: Thick layering

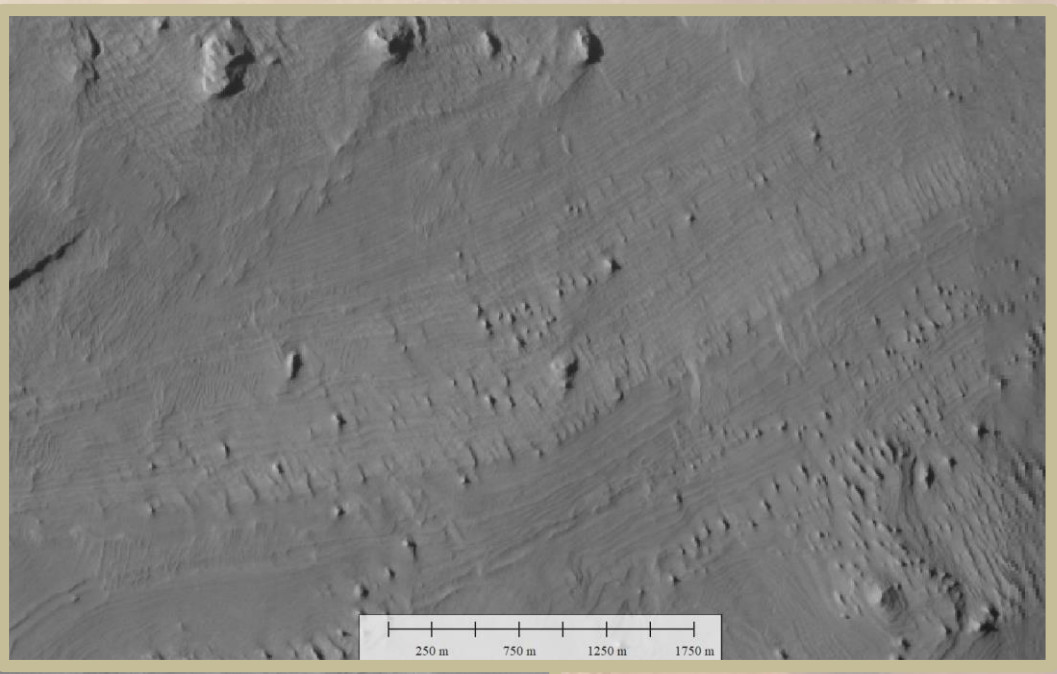
- light to intermediate toned
- visible thick (deca-meter) layering
- often produces erosional benches

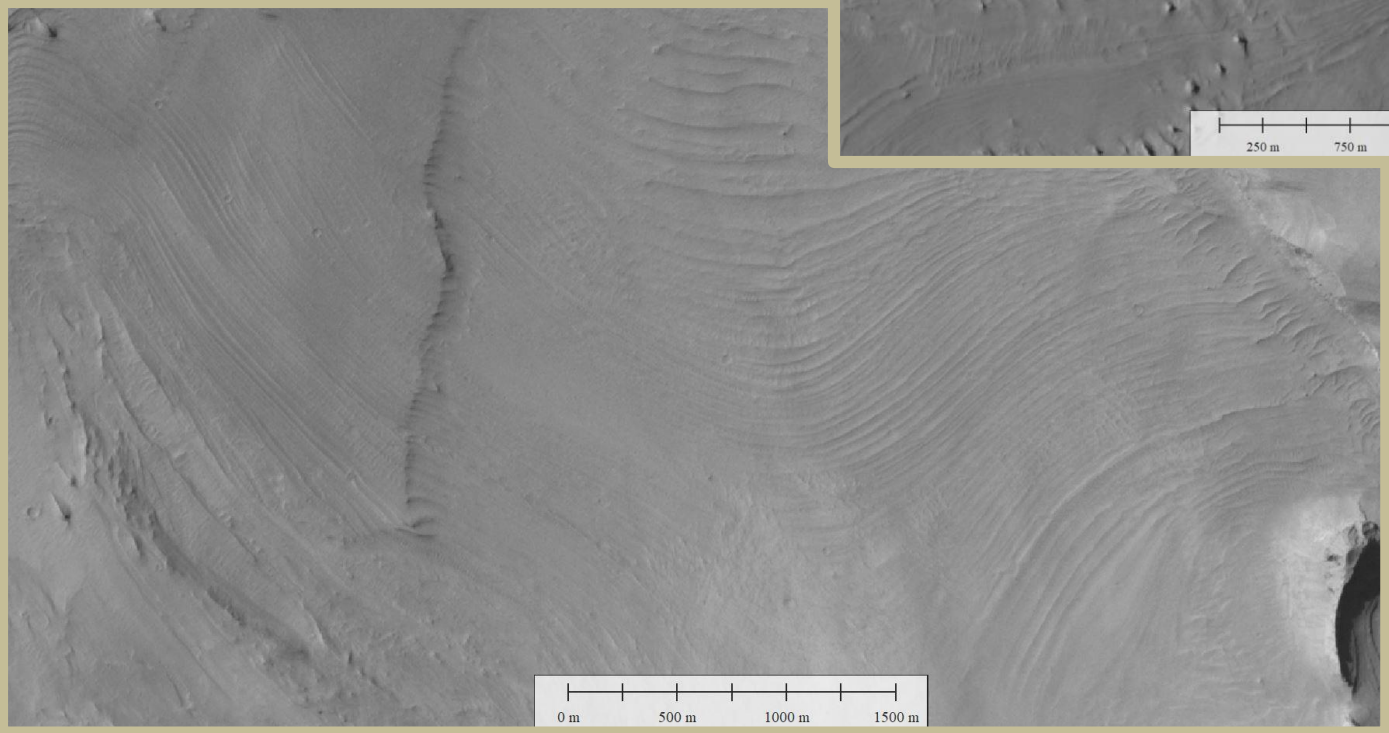




Units: Thin layering

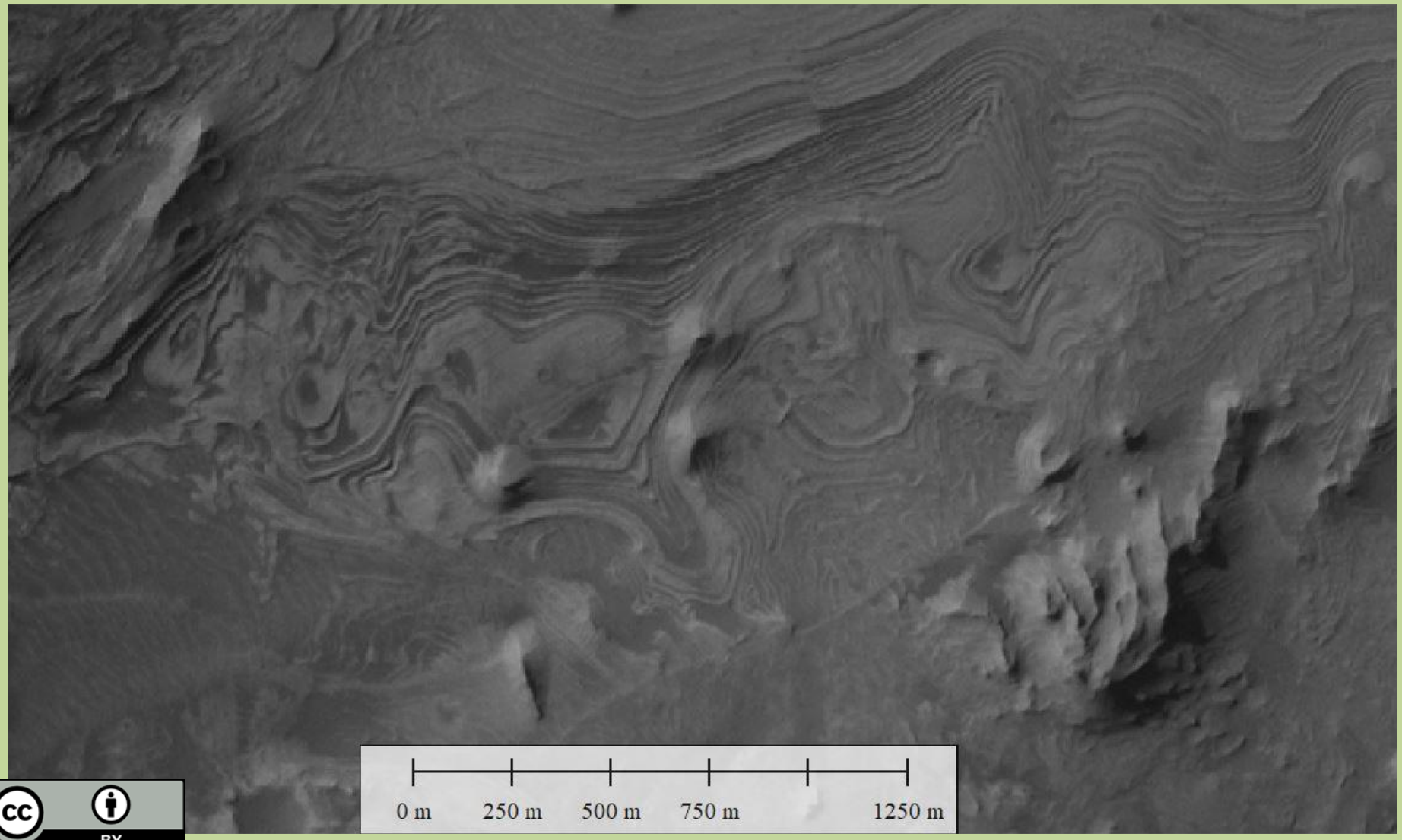
- light to intermediate in tone
- Layer thickness < 10 m
- Packages have hundreds of beds
- Smooth erosion suggests little competency contrast between layers





Units: Deformed layering

Deformed, most likely equivalent to Late Sedimentary Deposits (LSD) of Okubo (2010, doi:10.1016/j.icarus.2009.11.012)

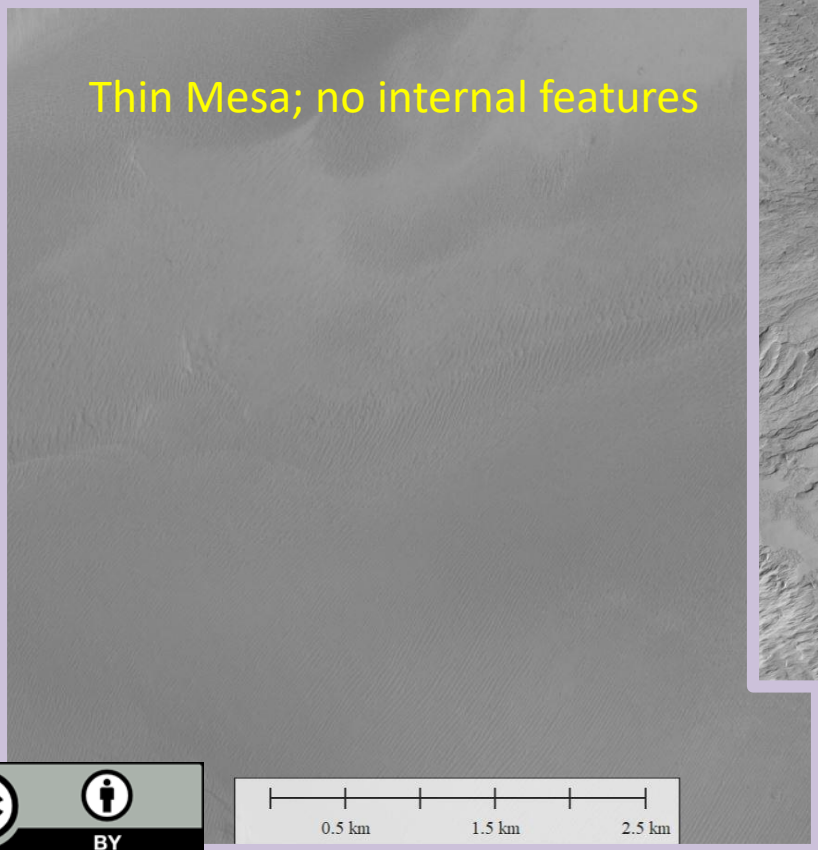


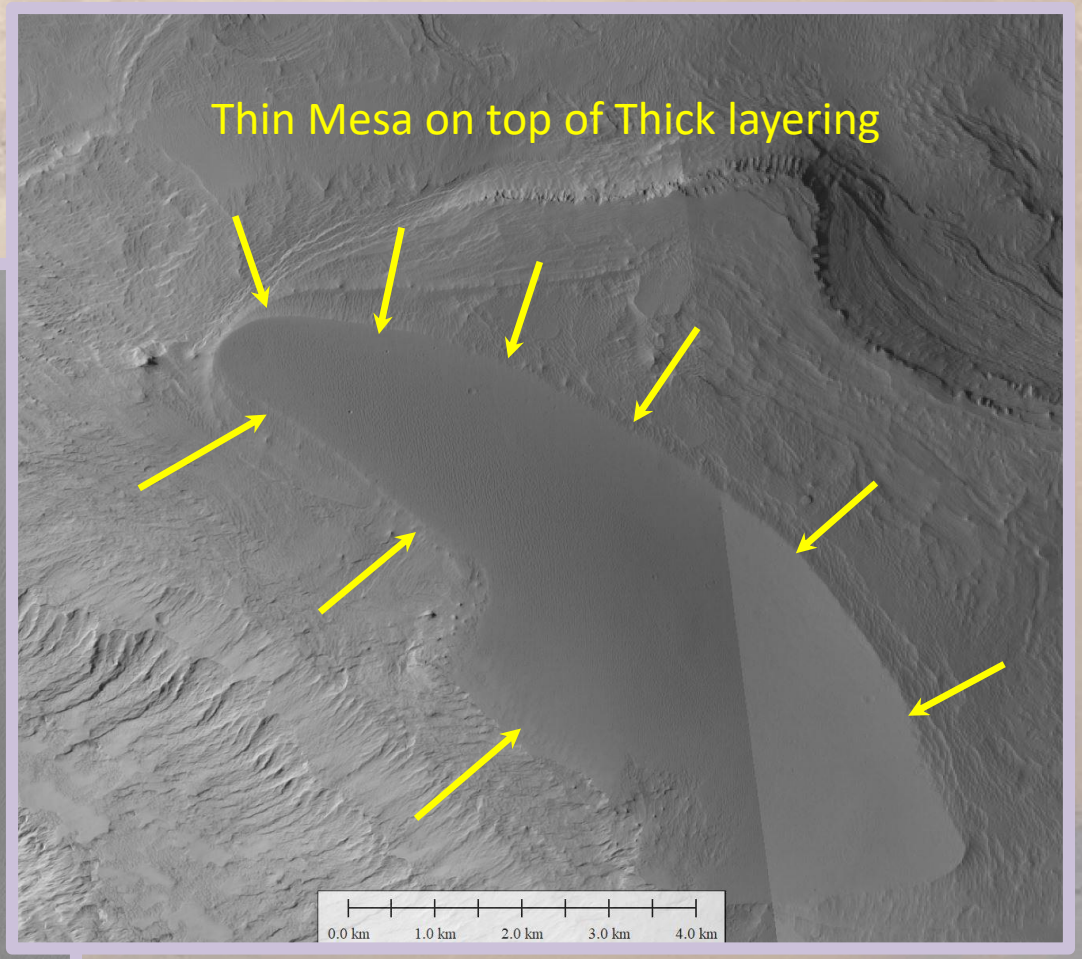
Units: Thin Mesa

Late, dark uniform cover without internal layering

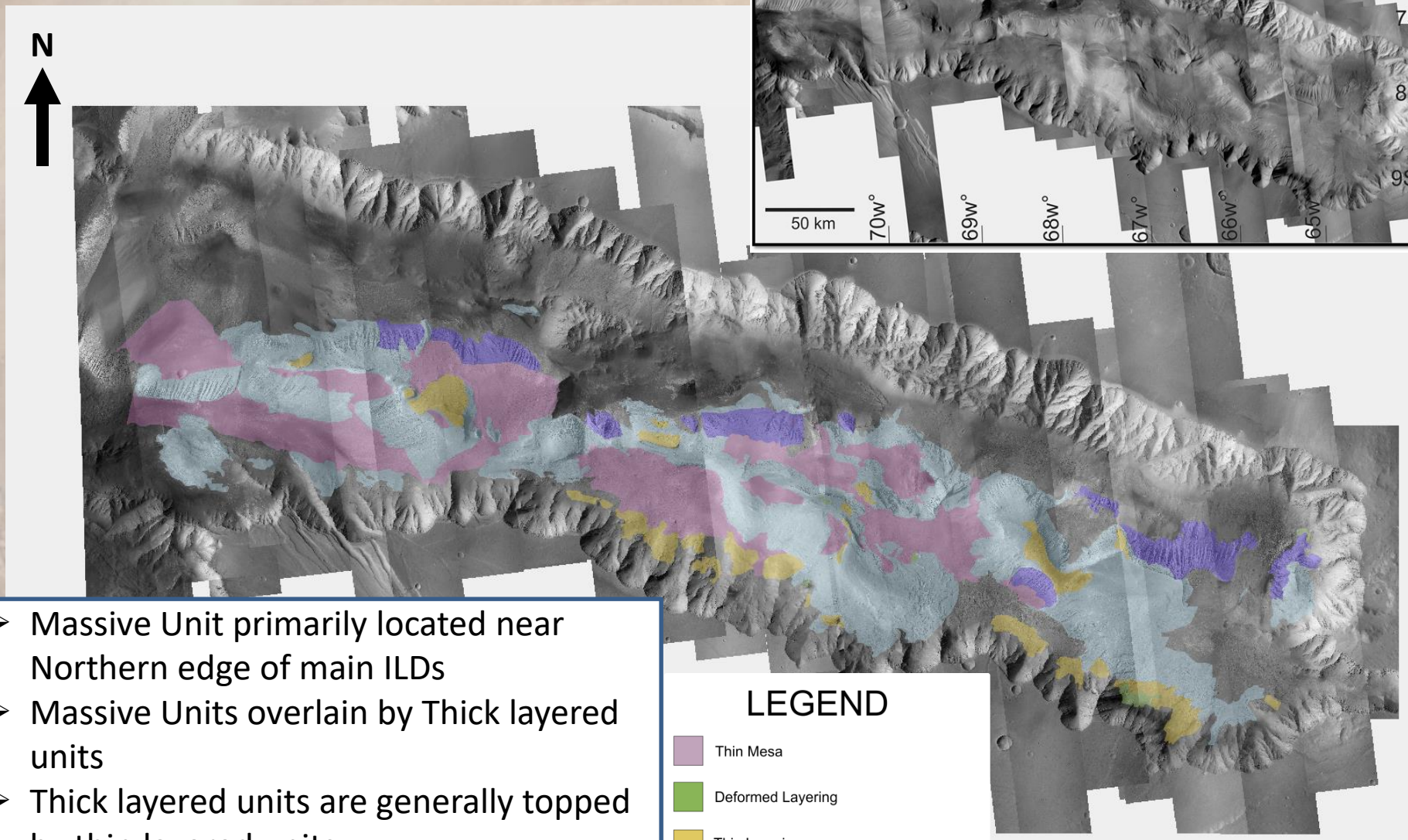
Term first coined by Malin & Edgett, 2000 (DOI: 10.1126/science.290.5498.1927)

Possible late volcanic ash cover



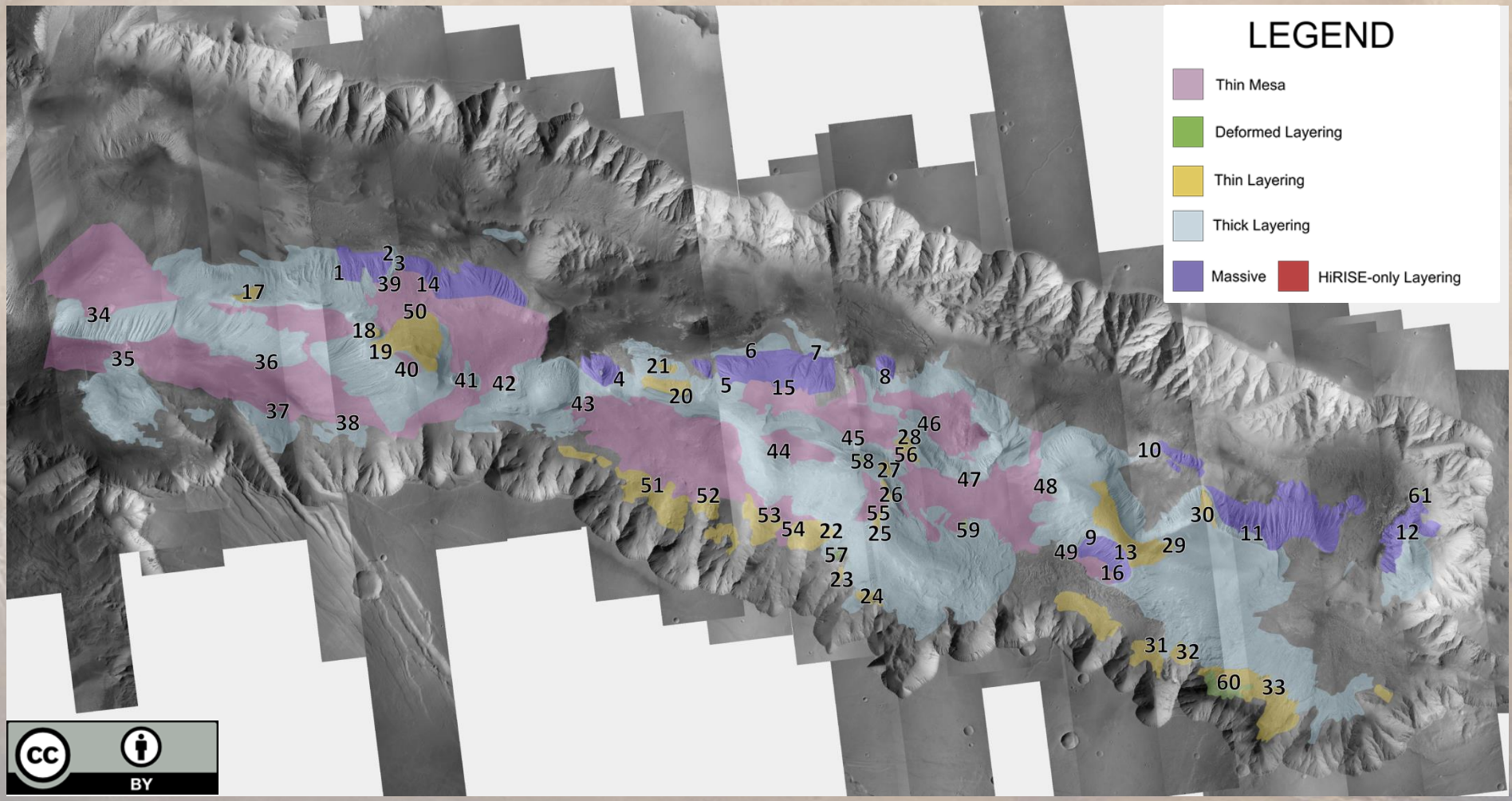


East Candor coverage



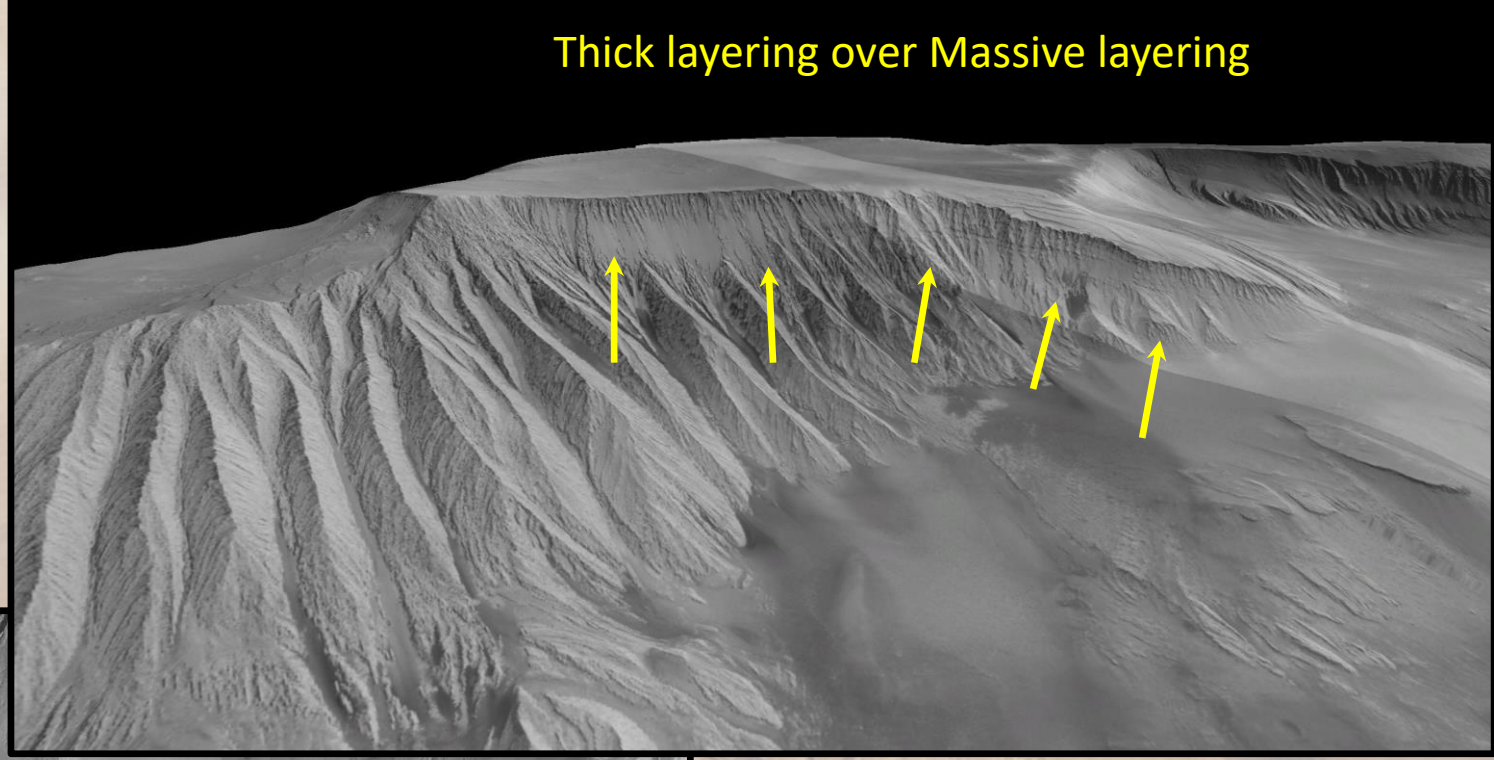
- Massive Unit primarily located near Northern edge of main ILDs
- Massive Units overlain by Thick layered units
- Thick layered units are generally topped by thin layered units
- Thin Mesa always on top

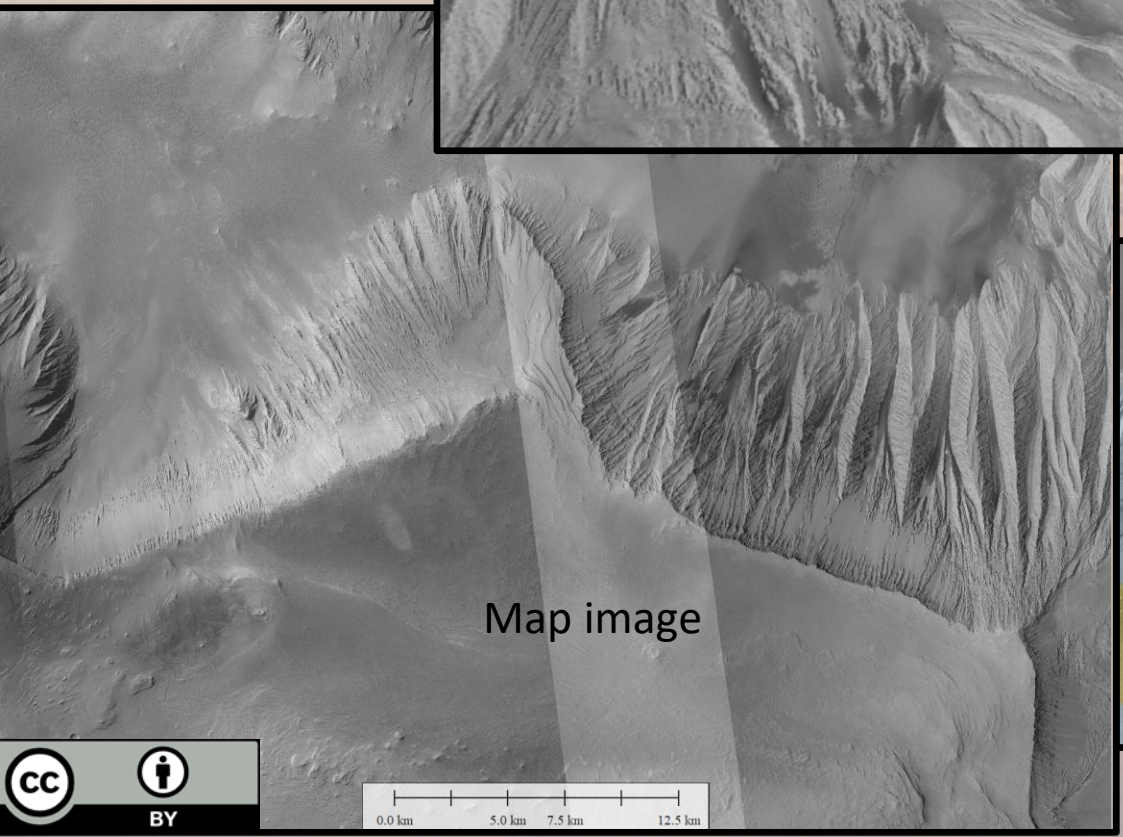
East Candor Unconformities



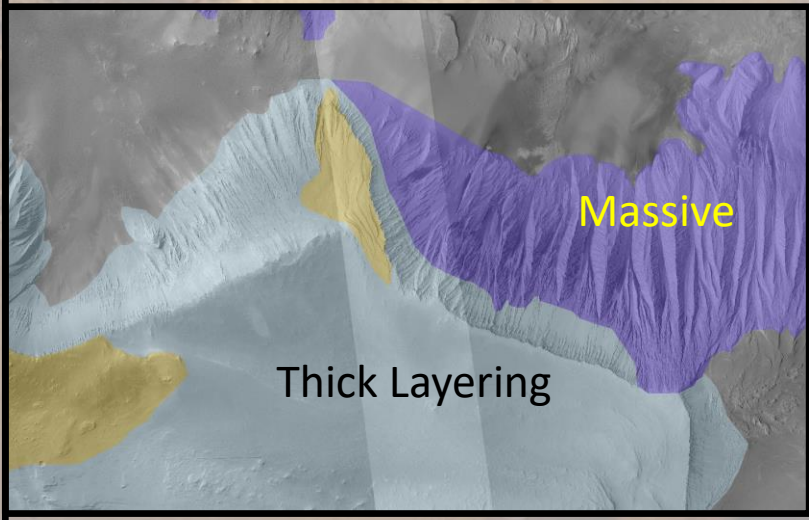
In total 62 boundaries between map units were identified. Most of these contacts can be demonstrated to being unconformable. Cross cutting relationships, changes in layer attitude and the large scale draping illustrated in the next slide clearly indicate a complex internal structure of the ILD mounds.

Unconformity example:
NE corner,
East Candor





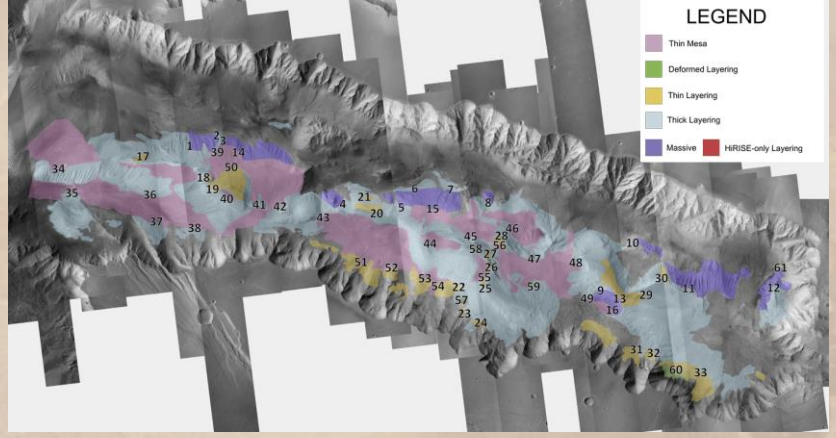
Mapped View

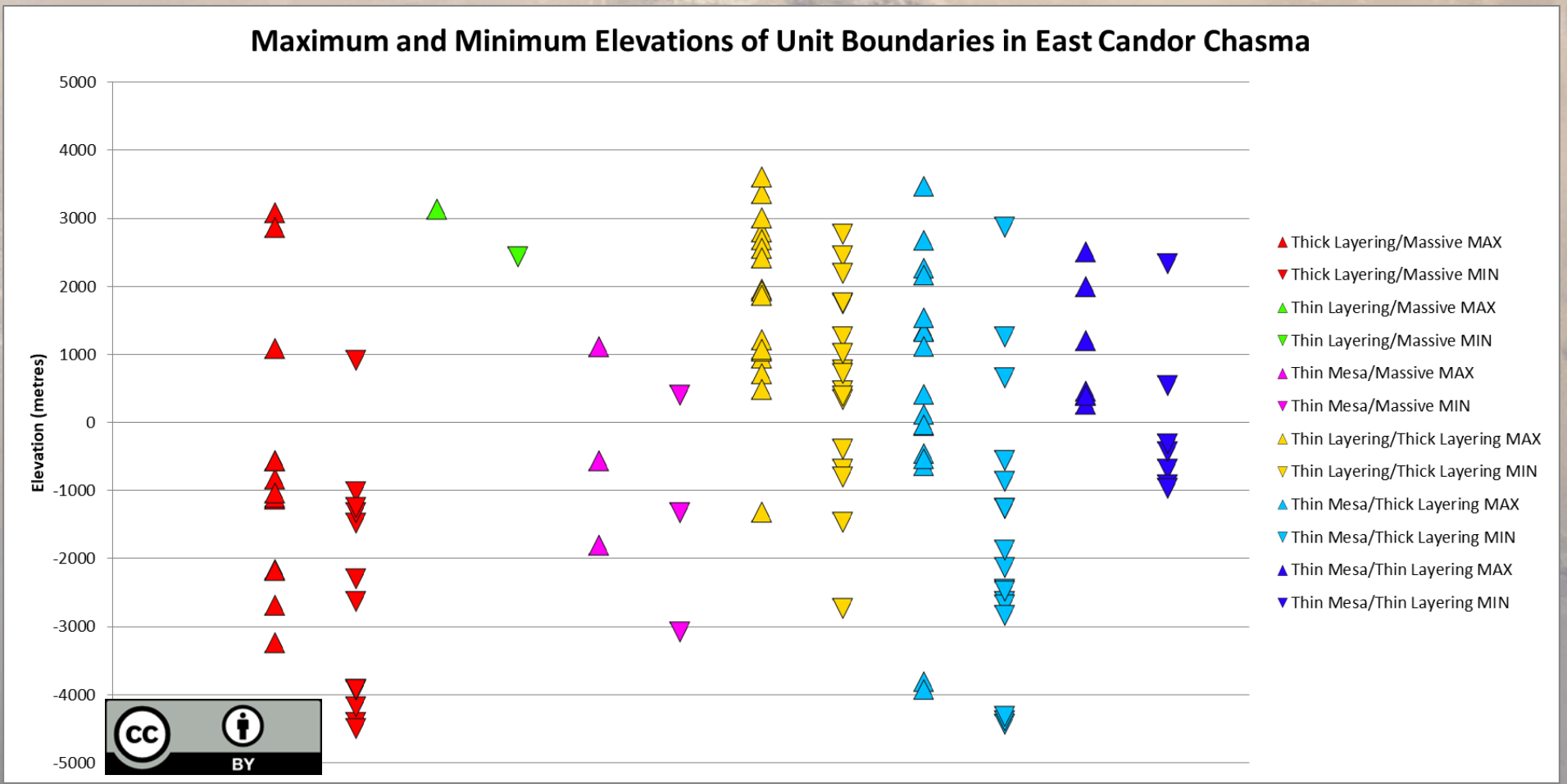


To simplify the graph below, each boundary is represented only by the **max** and **min elevations** (HRSC DTM) of that boundary's polyline.

The plot below illustrates the elevation range as well as the frequency of two units being in contact:

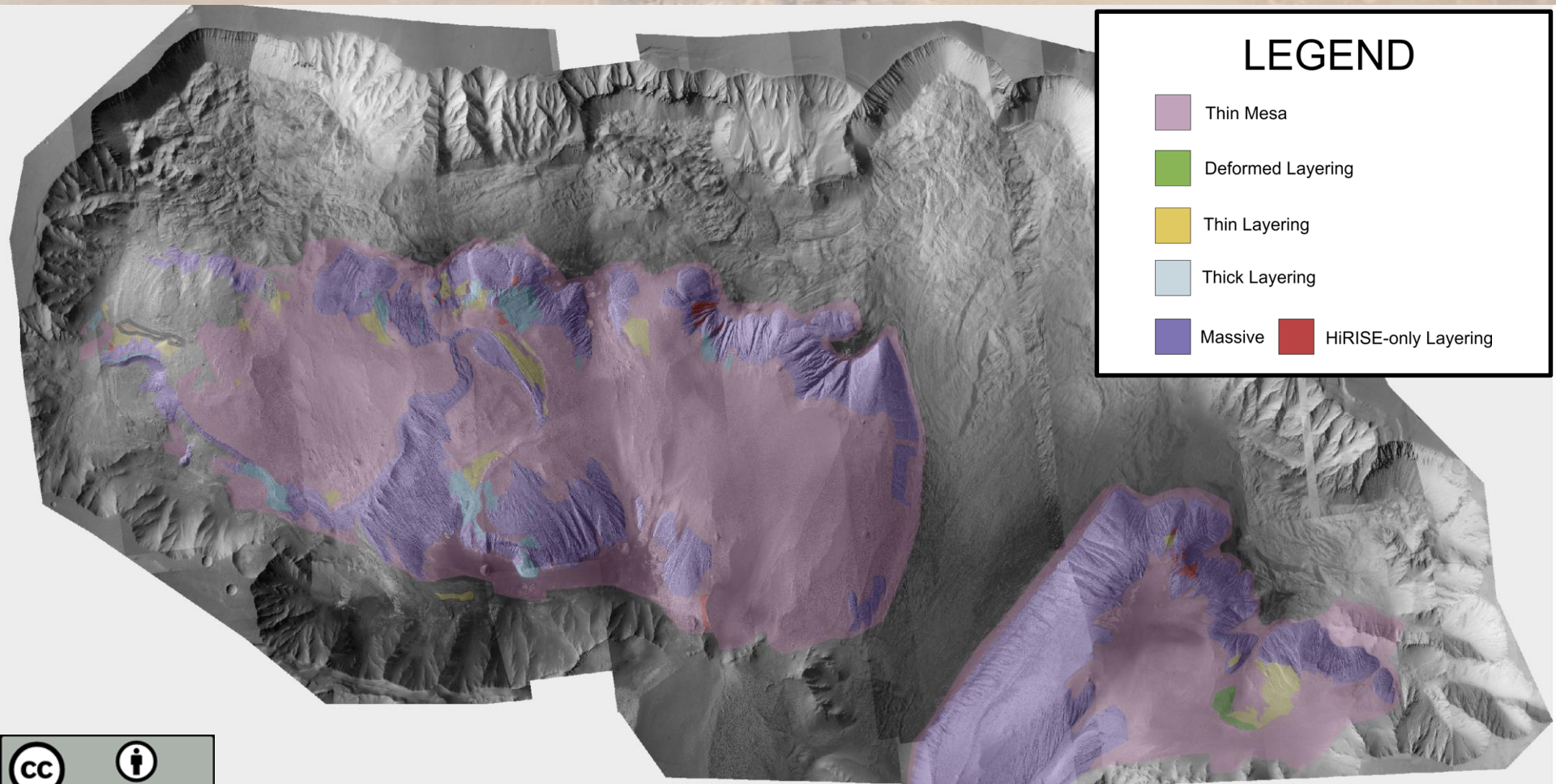
1) Boundaries span full elevation range in Chasm
2) Thick/Massive, Thin/Thick, Thin Mesa/others most common. (e.g. Thin/Massive is rare)





Ophir still work in progress. Preliminary results indicate:

- Massive forms base layer, often covered by Thick layering
- Thin layering primarily on top of Thick or Massive
- Thin Mesa much more extensive in Ophir than in east Candor



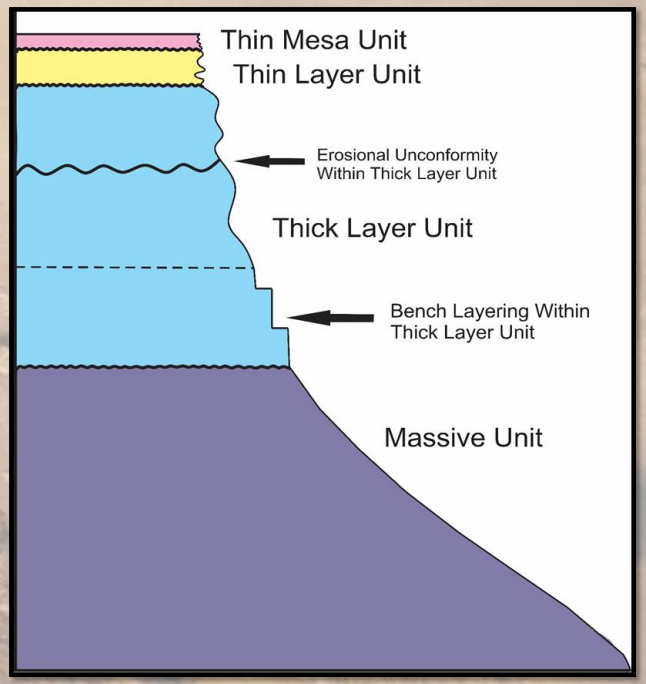
Preliminary conclusions and more questions

- **Ophir and East Candor share similar stratigraphy**
  (West Candor to come summer 2020)

- Massive units form base layer
- Most often covered by Thick layering
- Thick layering covered by Thin layering
- Thin Mesa covers all – clearly late

- Most contacts are demonstrably unconformities

- Simplified Stratigraphy as illustrated →
- Deformed layer only present near walls,
- not considered here for now



Thick layer units drape over Massive Units with a clearly curving topography. The example above spans an elevation range of several kilometers.
Is the topography of the massive unit an erosional or primary feature?

Layer thickness clearly decreases up the stratigraphic section. This points to significant changes in the environment during the infill of the chasms.
What is the nature of that change? Sediment supply? Environmental conditions?

The End (for now)

- This presentation is more of a progress report than a completed study. Our plan is to map West Candor after Ophir and I anticipate a short revisit of East Candor to re-examine it in the light of what we learned in the other 2 chasms.
- If you have comments, please don't hesitate to contact me at ffueten@brocku.ca

- Finally I would like to thank my co-authors, especially the students who toiled away countless hours in front of a computer monitor. Without your work, this presentation would not have been possible. And thank you for engaging in countless hours of discussions with me, which I thoroughly enjoyed.