

Dating of planetary surface units: correct utilisation of crater size-frequency determinations

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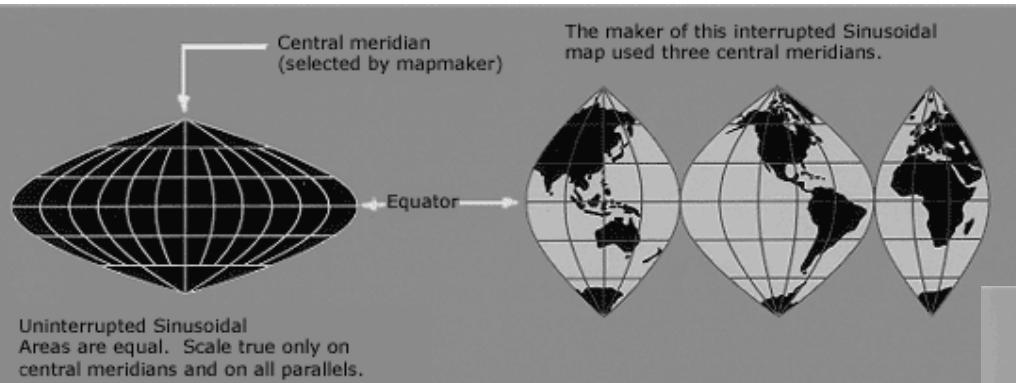
- Preparation of raster datasets
 - Projection
 - Image processing
- Mapping
- Crater counting
- Analysing data
- Interpreting data



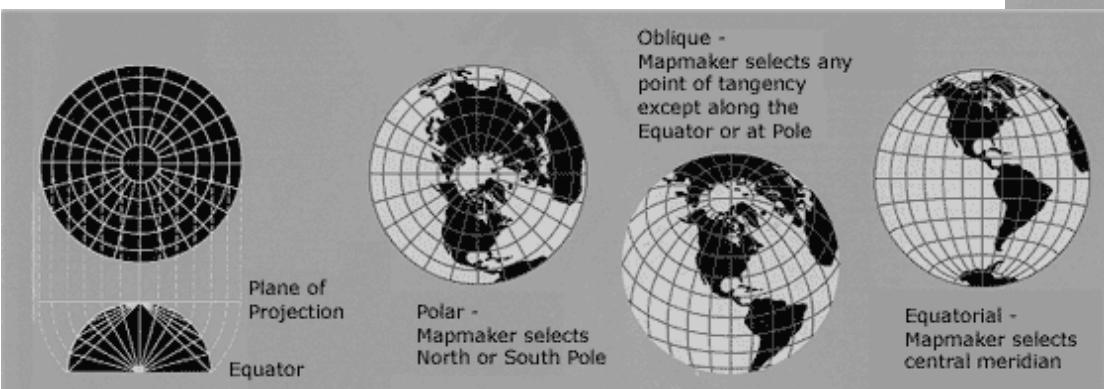
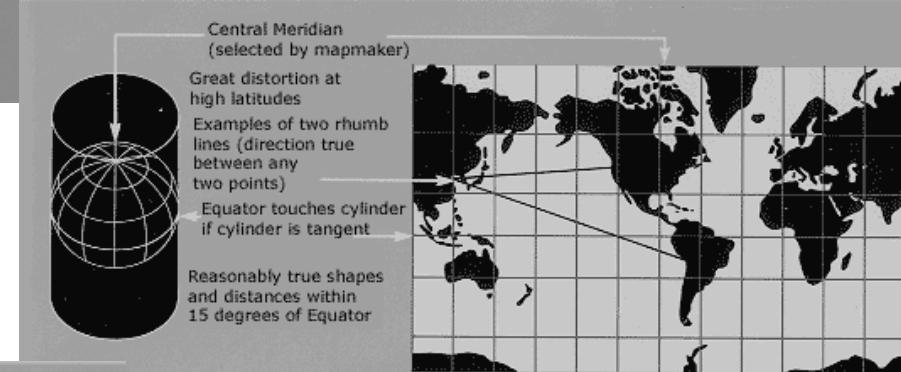
Depending on *latitudinal* and *longitudinal* range of the study area appropriate projection needs to be selected
e.g., Mercator, Lambert, Polar stereographic, Sinusoidal



<http://egsc.usgs.gov/isb/pubs/MapProjections/projections.html>



Sinusoidal Equal Area



Lambert Azimuthal Equal Area



Depending on *latitudinal* and *longitudinal* range of the study area appropriate projection needs to be selected

e.g., Mercator, Lambert, Polar stereographic, Sinusoidal

<http://egsc.usgs.gov/isb/pubs/MapProjections/projections.html>

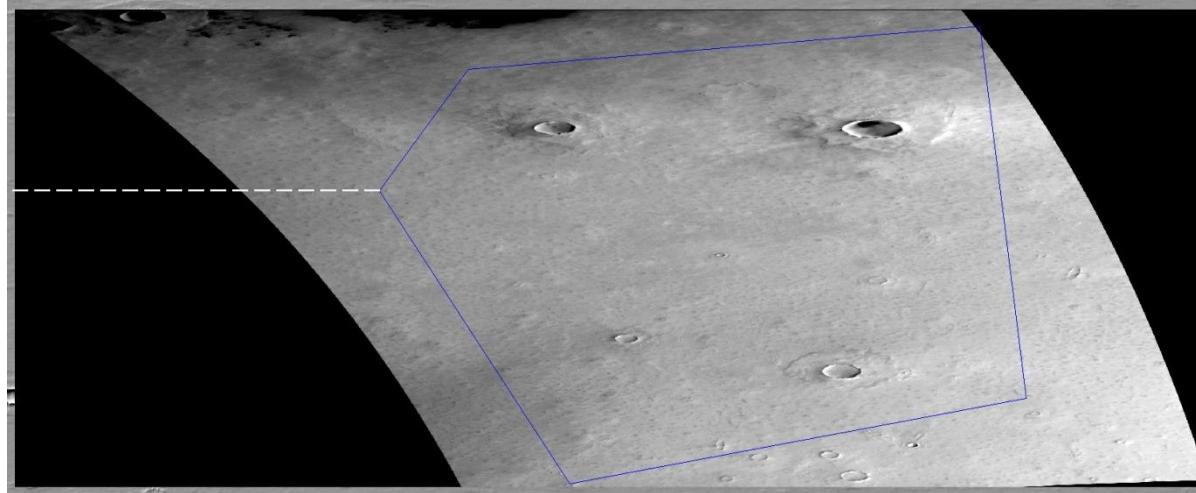
Map projection can be different from crater counting projection
=> easier for counting if craters appear nearly circular

Preparation of Raster Datasets

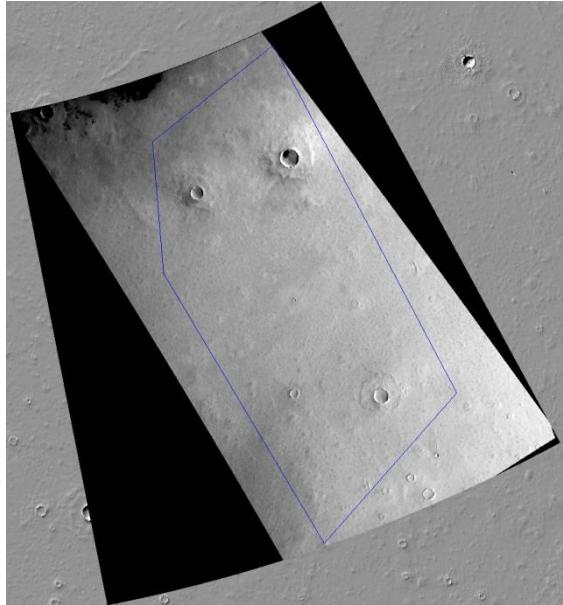


72°N

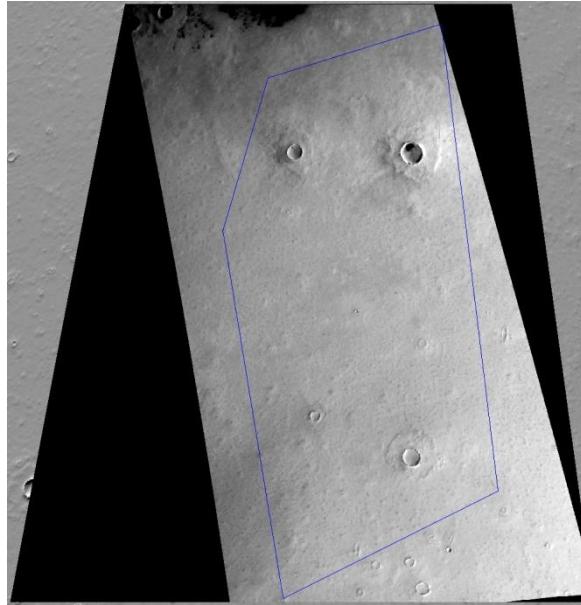
Equidistant-
cylindrical



Lambert
conformal conic
Parallels at 60°



Sinusoidal
centred at 24.5°





If same projection is used for the mapping and counting project, data handling will be fastest in ArcGIS

=> select suitable projection to process all raster data

e.g., all CTX etc in Equidistant cylindrical with same centre longitude
(set the parameters.map right)



- At what scale will be mapped?
=>determines datasets
- What is the areal extent of the unit/map area?
=> determines projection

Modelling unit surface ages using crater statistics:

- What are the thicknesses of major units and at what scale was mapped?
=> determines the minimum crater diameter needed
- What is the approximate age – young or old?
=> determines the size of the counting area



Examples of scales on Mars:

THEMIS IR day/night for large area

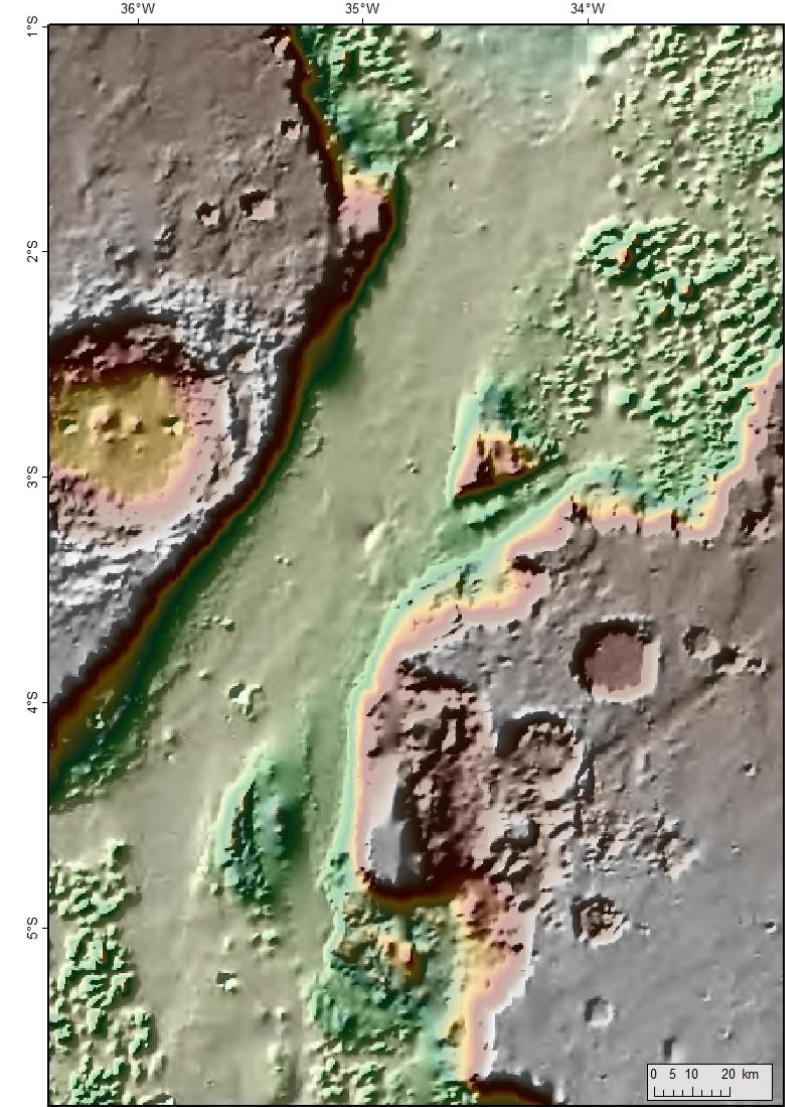
HRSC/CTX for intermediate areas

HiRISE/MOC/CTX for small areas

Mapping of Surface Units

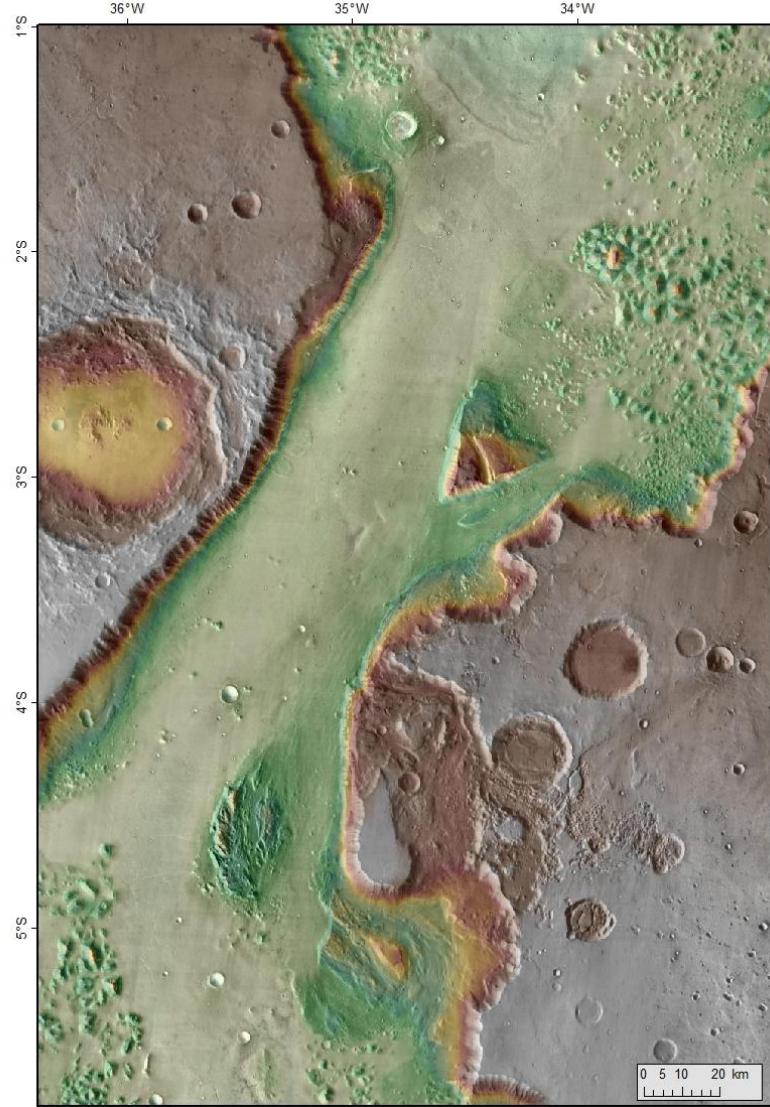


MOLA DTM on hillshade; 463 m/px



Simud Valles

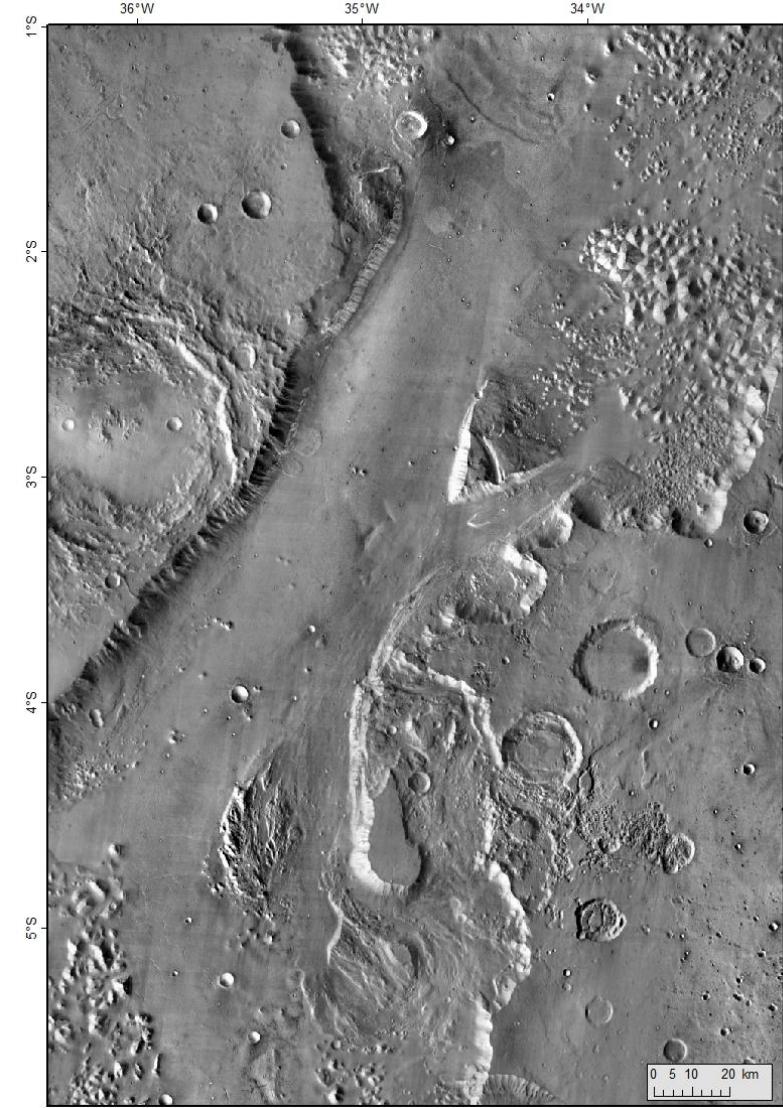
MOLA DTM on THEMIS IR day; 100 m/px



Mapping of Surface Units

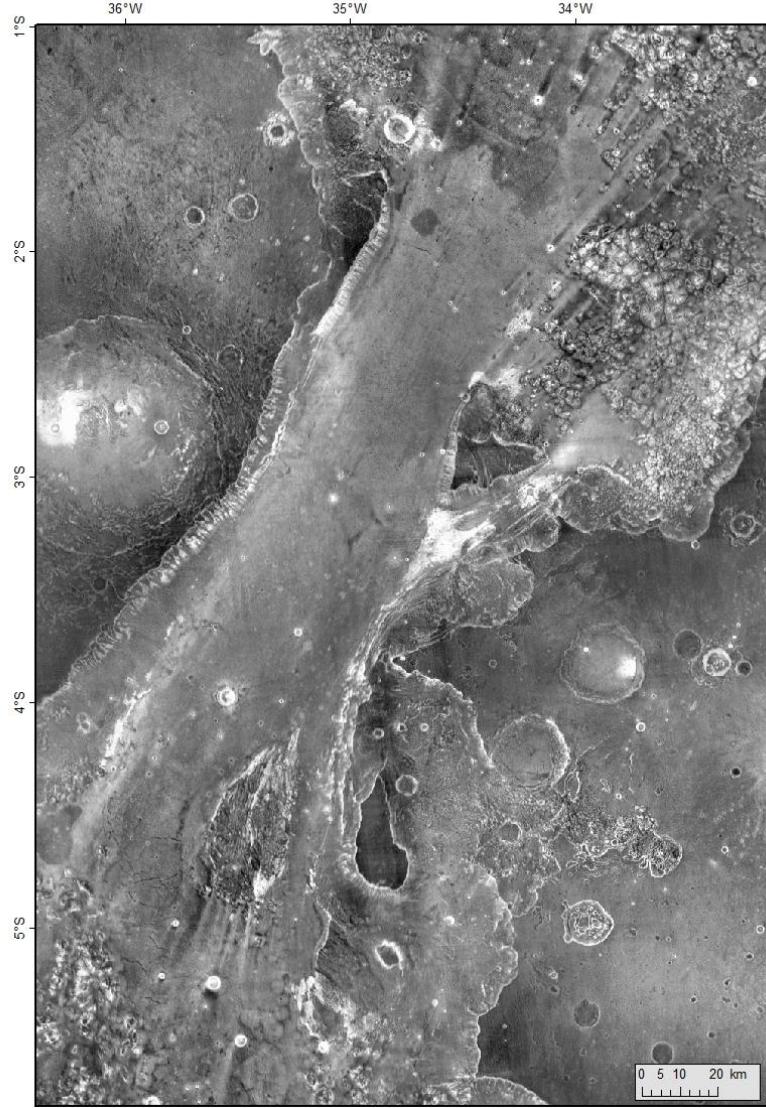


THEMIS IR day; 100 m/px



Simud Valles

THEMIS IR night; 100 m/px



Mapping of Surface Units

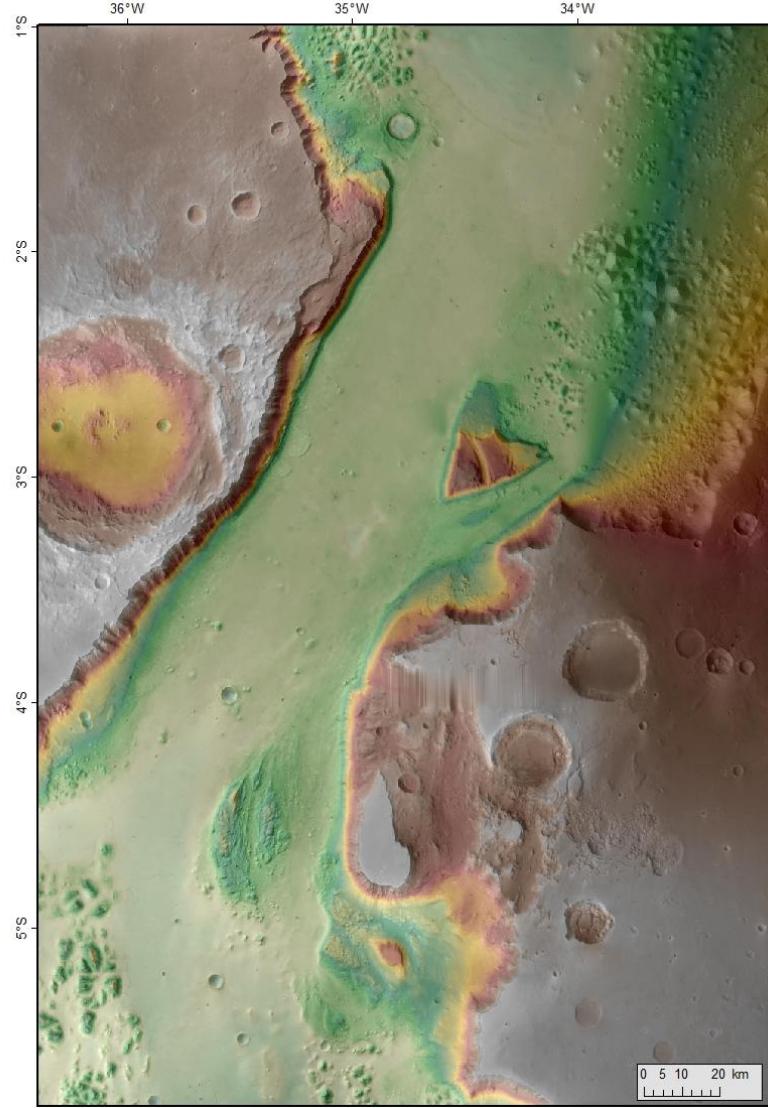


HRSC nadir mosaic; 12.5 m/px



Simud Valles

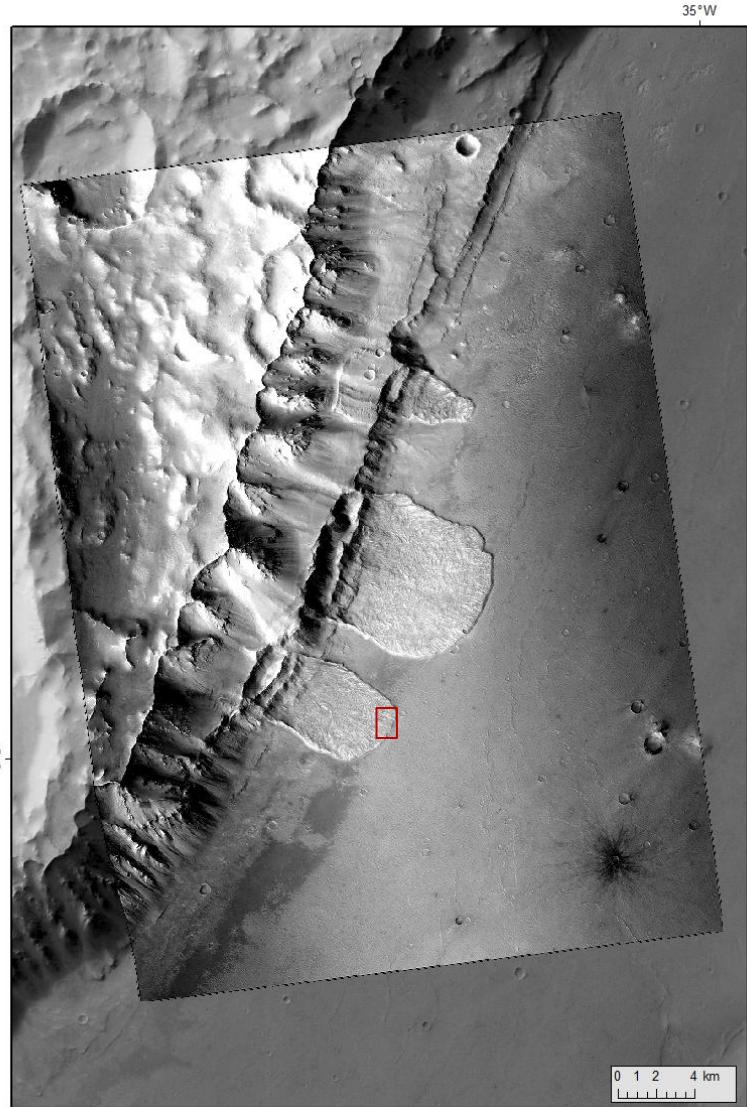
HRSC-DTM on nadir mosaic; 100 m/px



Mapping of Surface Units

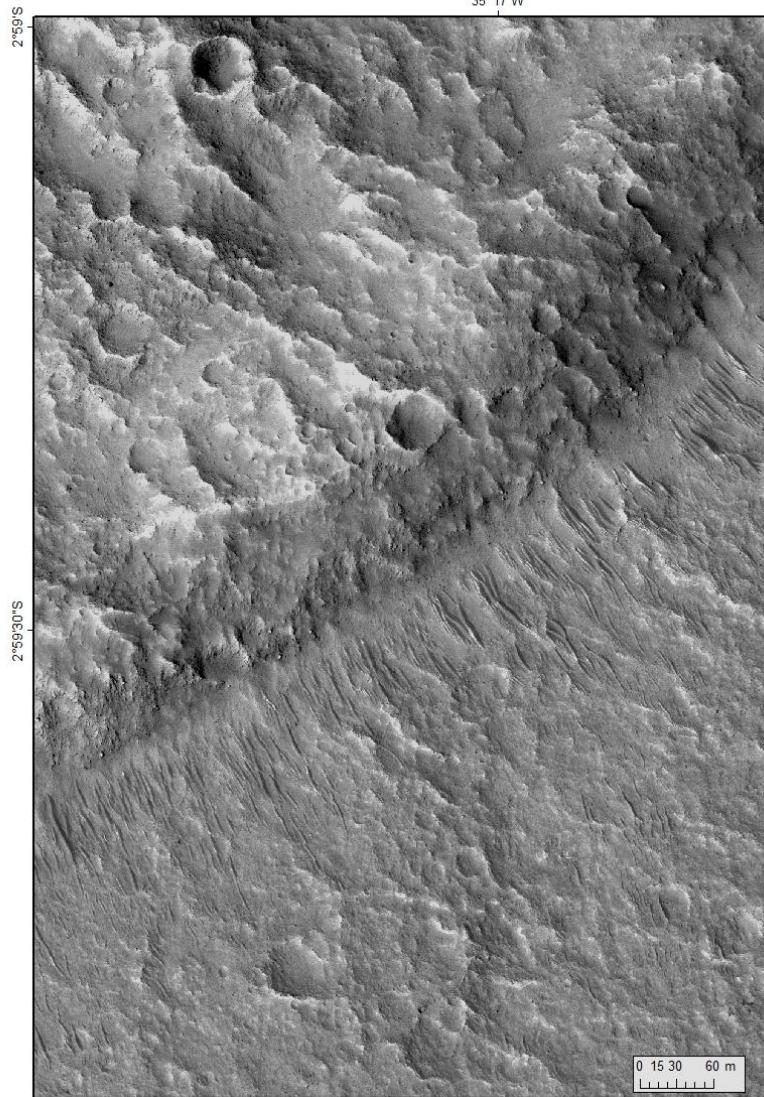


CTX; 5.5 m/px



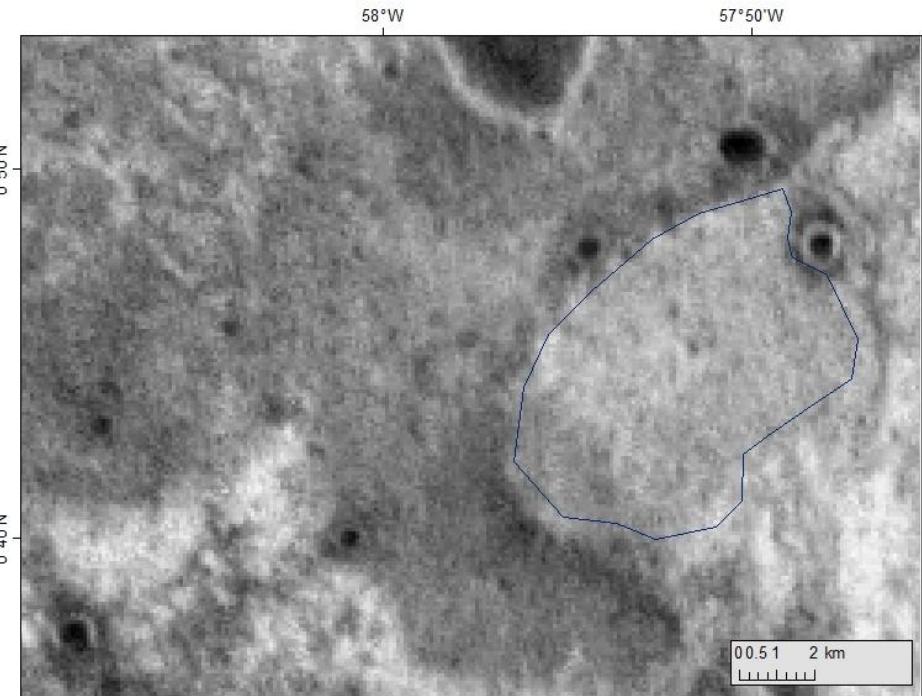
Simud Valles

HiRISE; 0.25 m/px

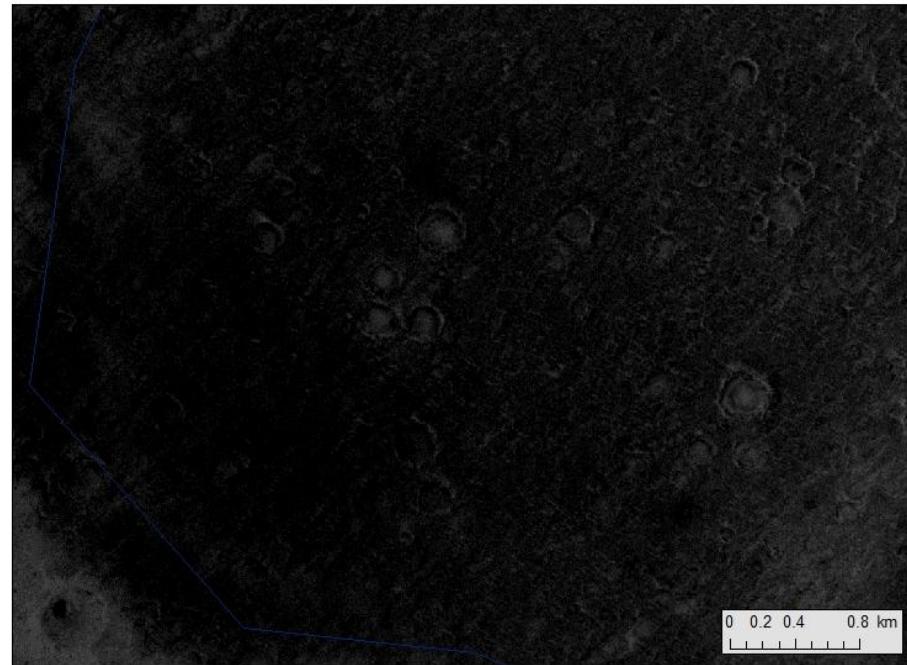




Havel Vallis



THEMIS IR night

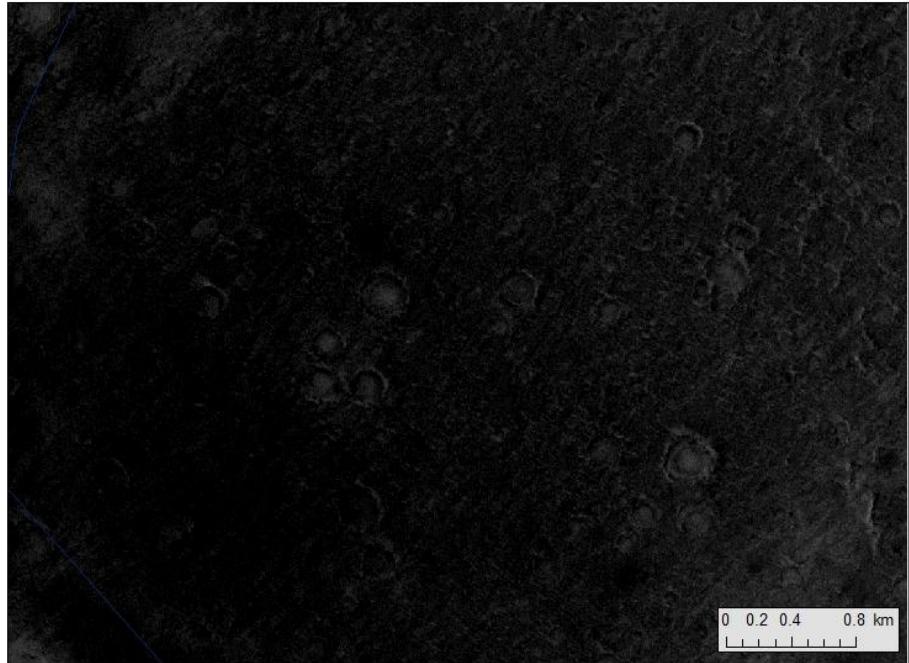


P11_005504_1795_XN_00S057W

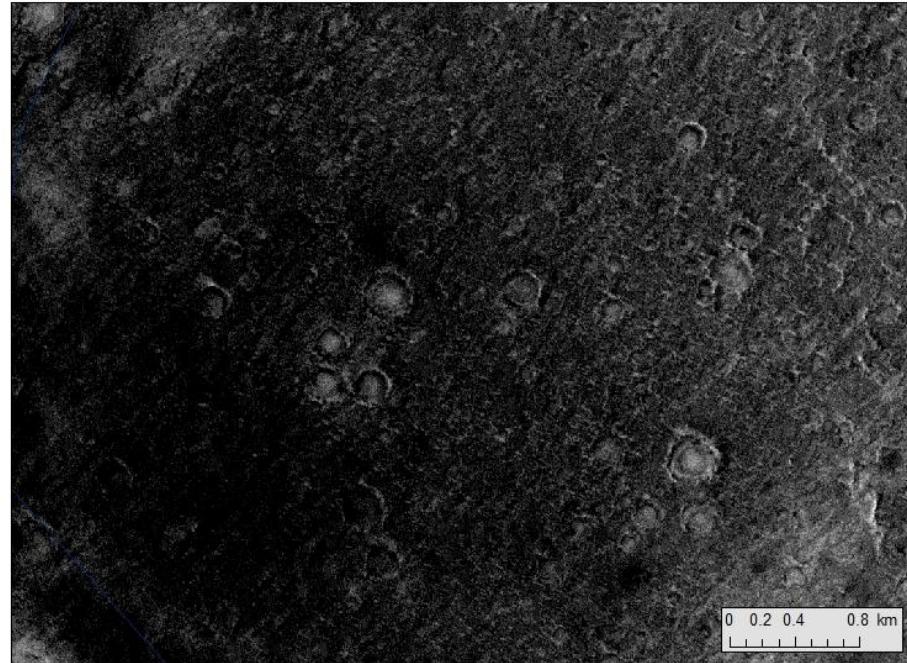
if mapped on THEMIS
=> offset to CTX
=> check unit boundaries



Havel Vallis



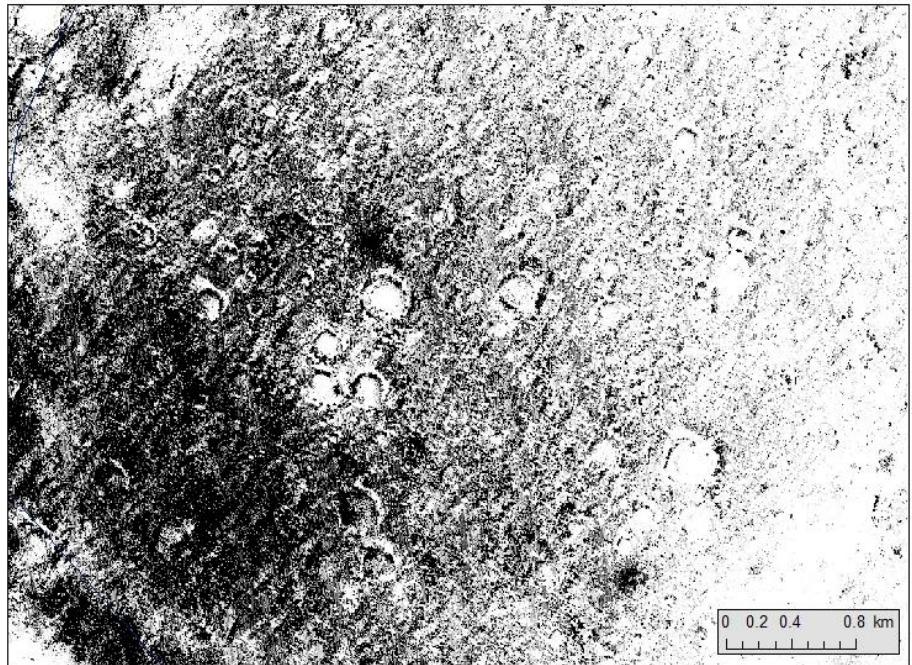
CTX min-max



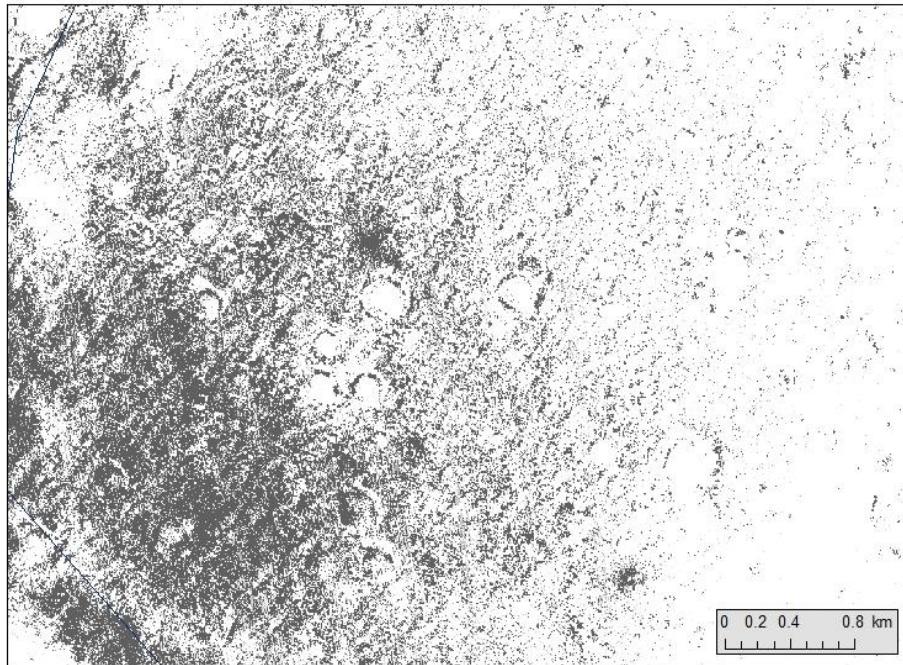
CTX min-max to current extent



Havel Vallis



CTX equalised to current extent



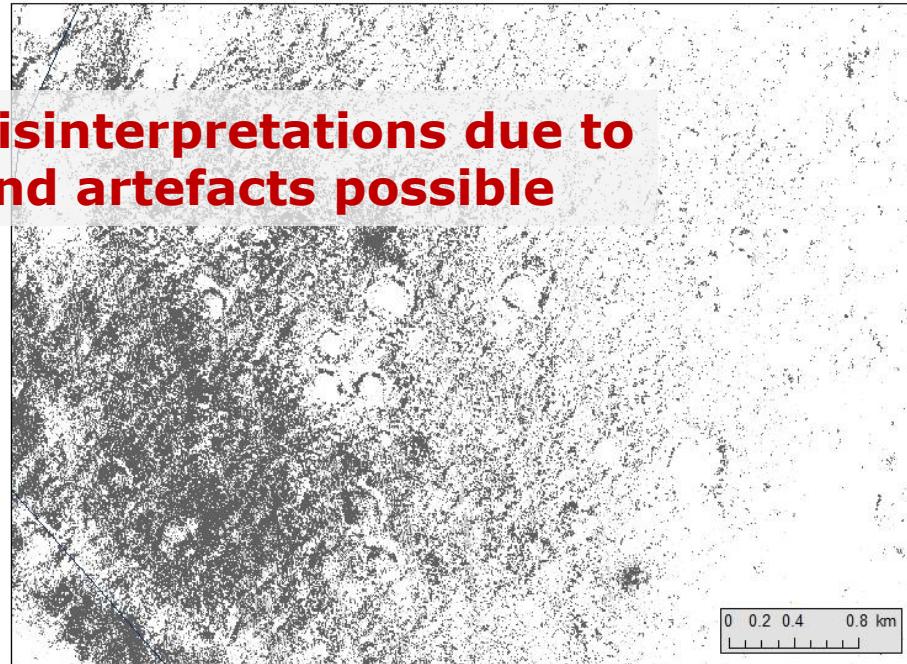
CTX equalised to current extent
plus brightness/contrast



Havel Vallis



CTX equalised to current extent



CTX equalised to current extent
plus brightness/contrast



The counting area should be a unit that has been emplaced by one and the same distinct process within a distinct period of time (Wilhelms et al., 1987).

Take care that the crater counting areas do not cross geologic borders!



Take large areas for large craters.

Largest craters should be small compared to the counting area.

The formation rate of large craters is low. Thus, high numbers of large craters indicate old areas.

LROC, WAC, Moon (S32°/E146°)

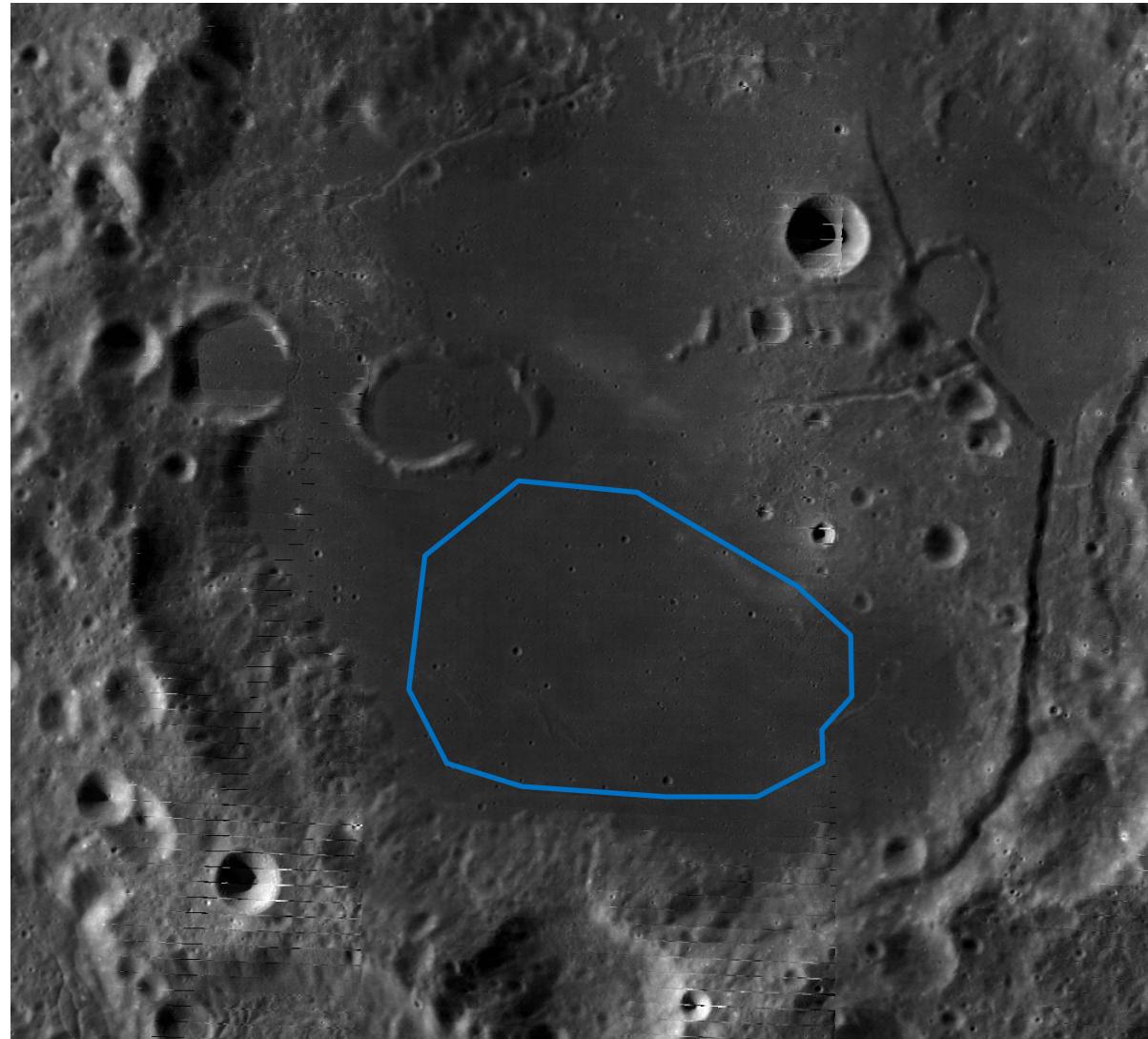




Take small areas
for small craters.

Counting small craters
on large areas is
extremely time
consuming, due to the
steep production
function.

The formation rate of
small craters is high.
Thus, they indicate
young areas, where they
are few.



LROC, WAC, Moon (S32°/E146°)

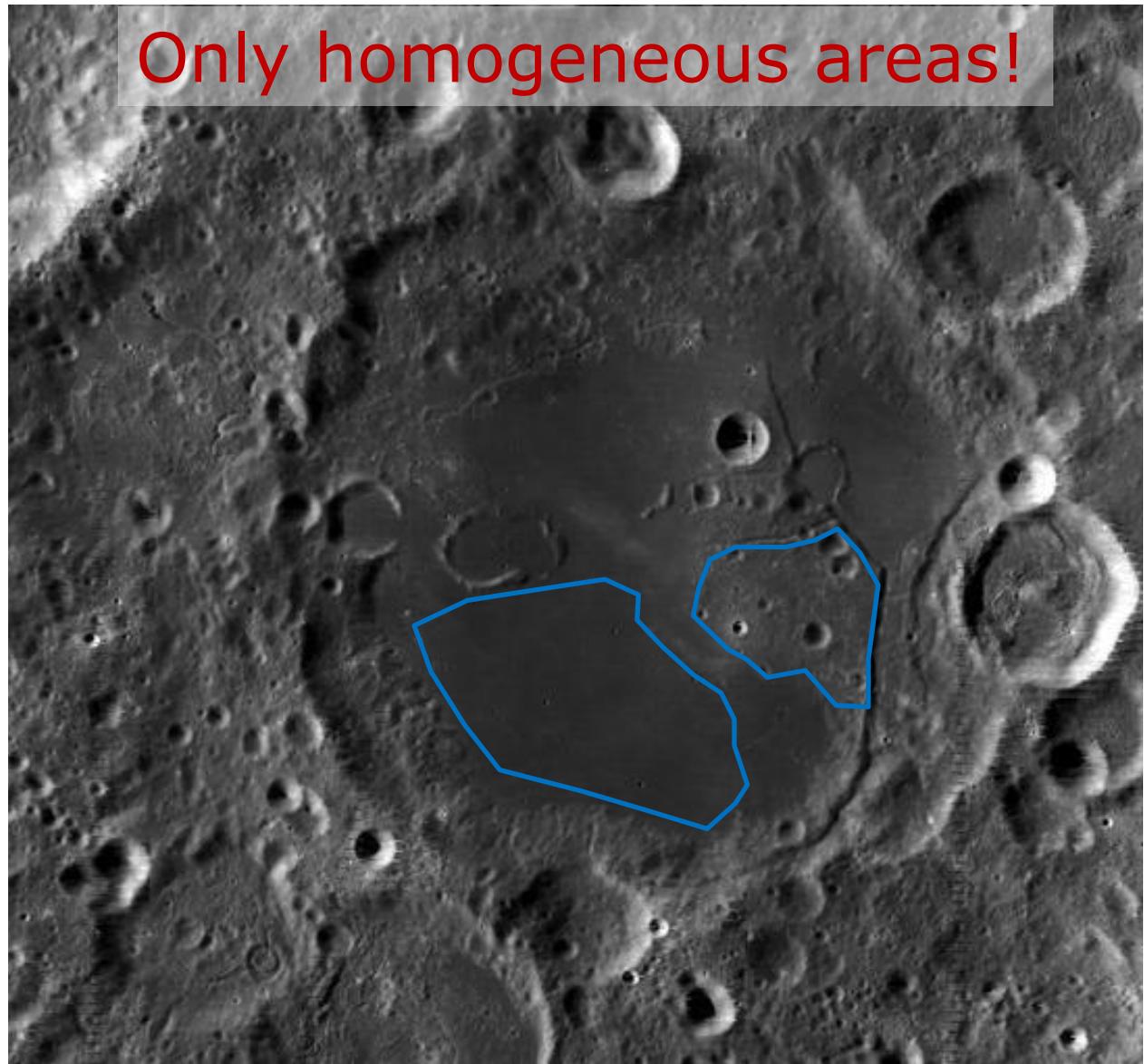




Image artefacts can affect crater SFDs.

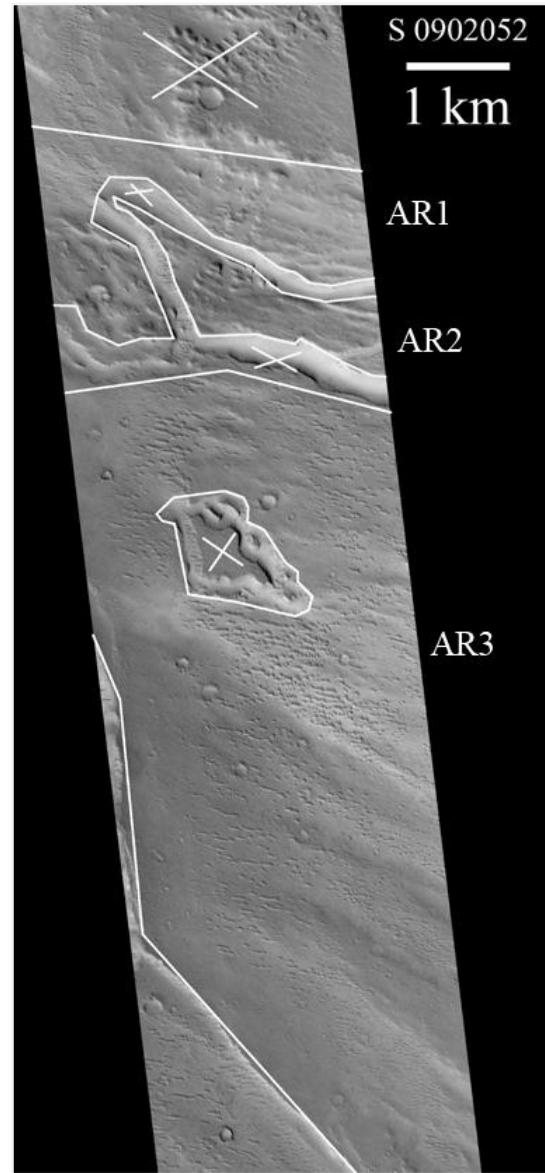


LROC, WAC, Moon (S32°/E146°)

Mapping a Counting Area



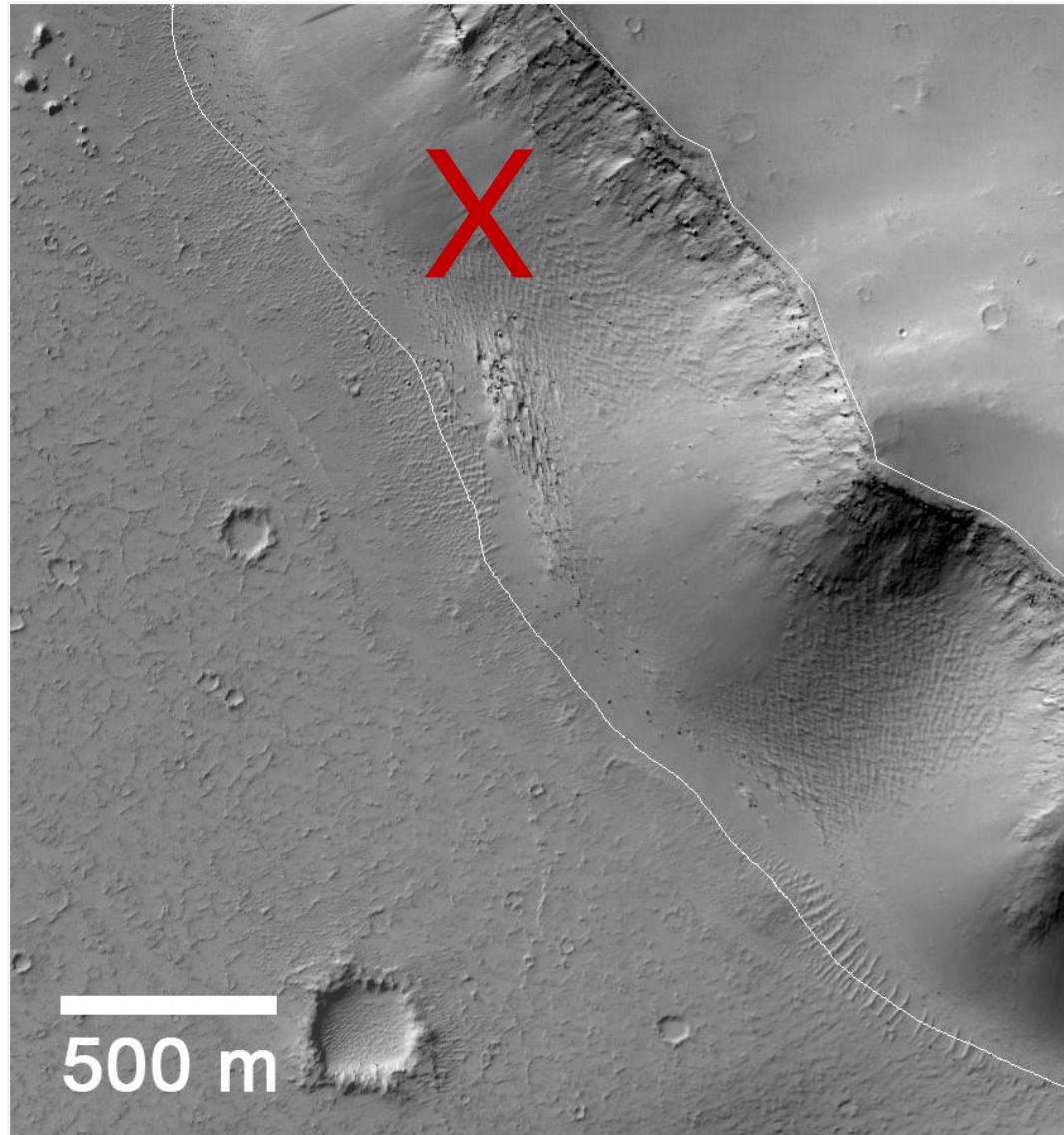
- separate geol./geomorph. units



Mapping a Counting Area



- separate geol./geomorph. units
- don't select steeply inclined surface, i.e. hillsides etc.
=> erosion/coverage of craters due to mass transport

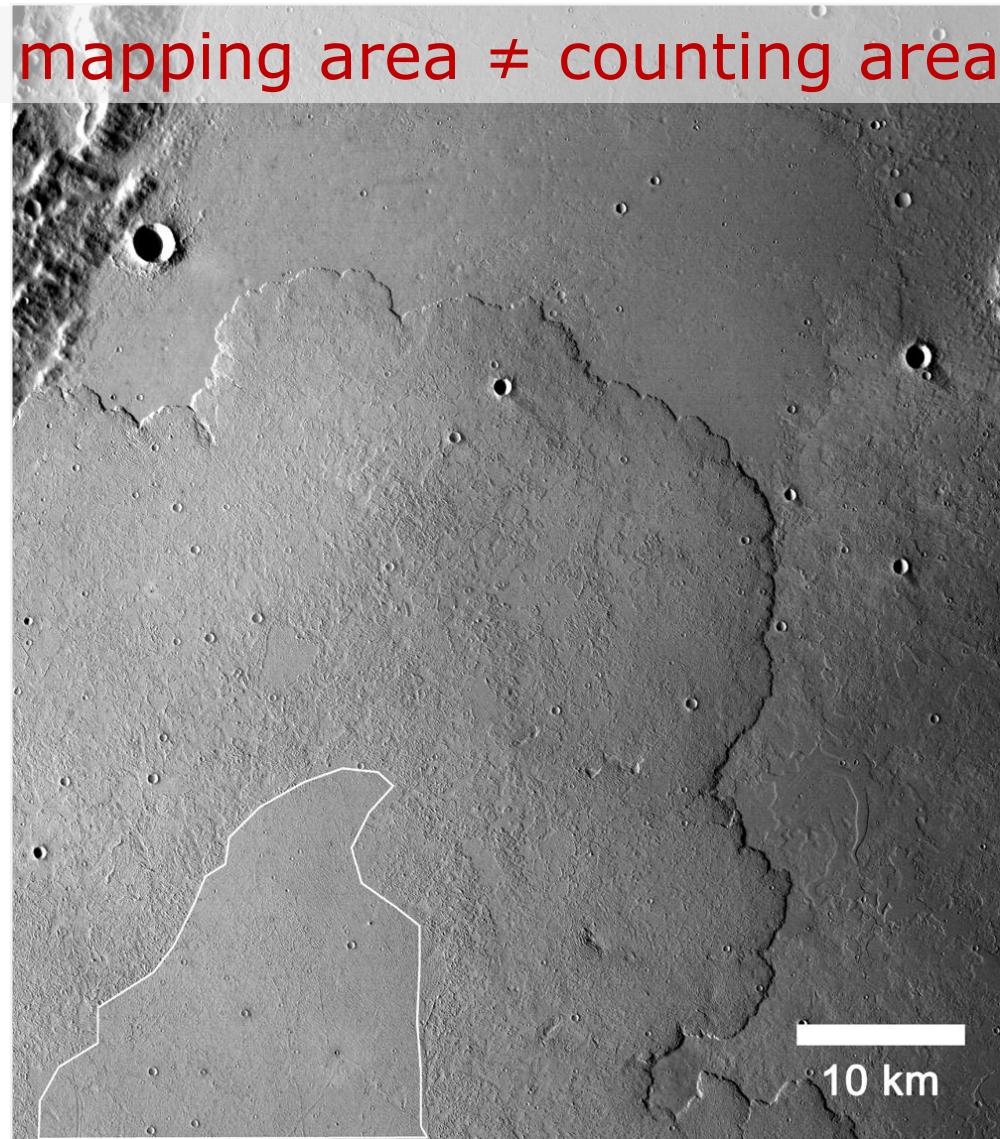


Mapping a Counting Area



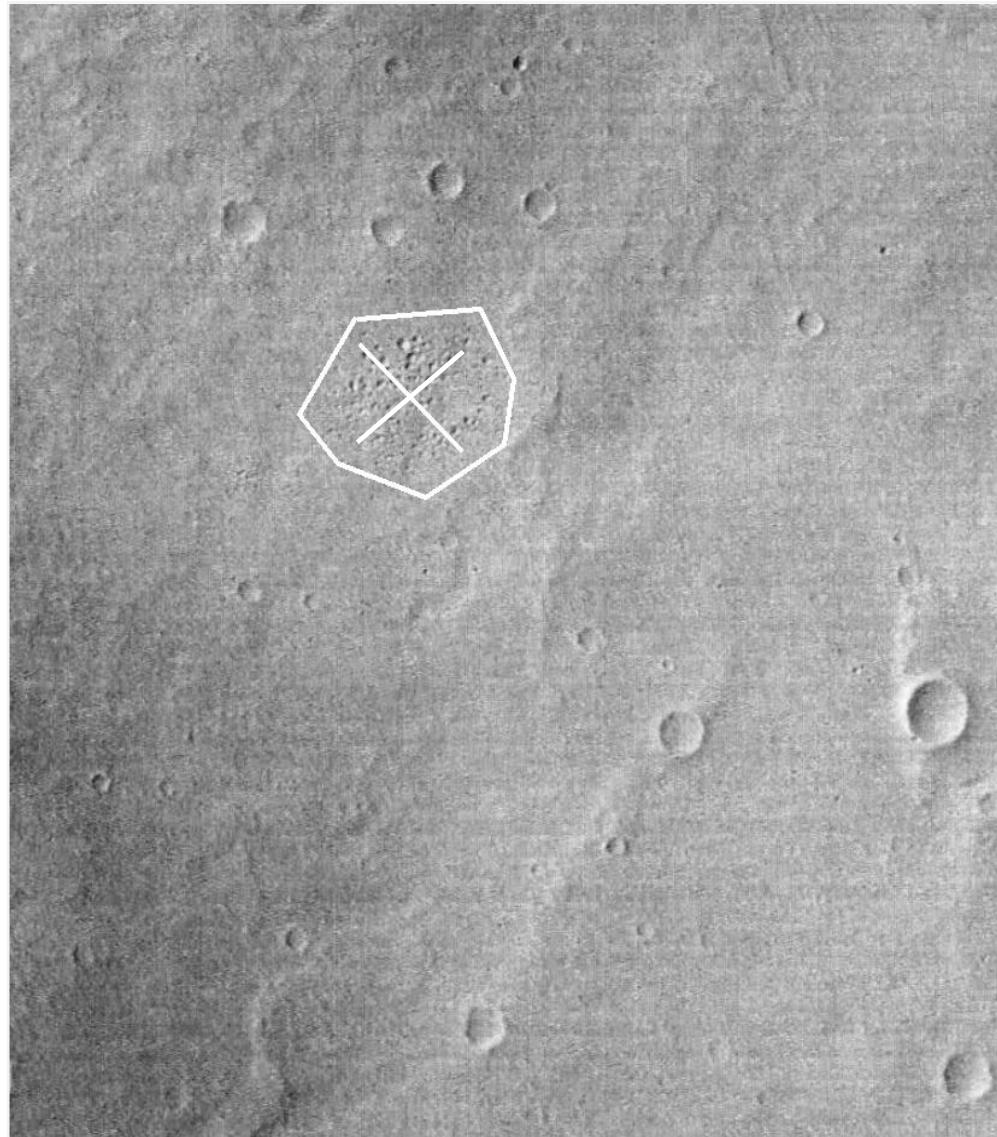
- separate geol./geomorph. units
- don't select steeply inclined surface, i.e. hillsides etc.
=> erosion/coverage of craters due to mass transport
- homogenous texture
- avoid rough surfaces

HRSC orbit 4095





- separate geol./geomorph. units
- don't select steeply inclined surface, i.e. hillsides etc.
=> erosion/coverage of craters due to mass transport
- homogenous texture
- avoid rough surfaces
- exclude secondary crater clusters

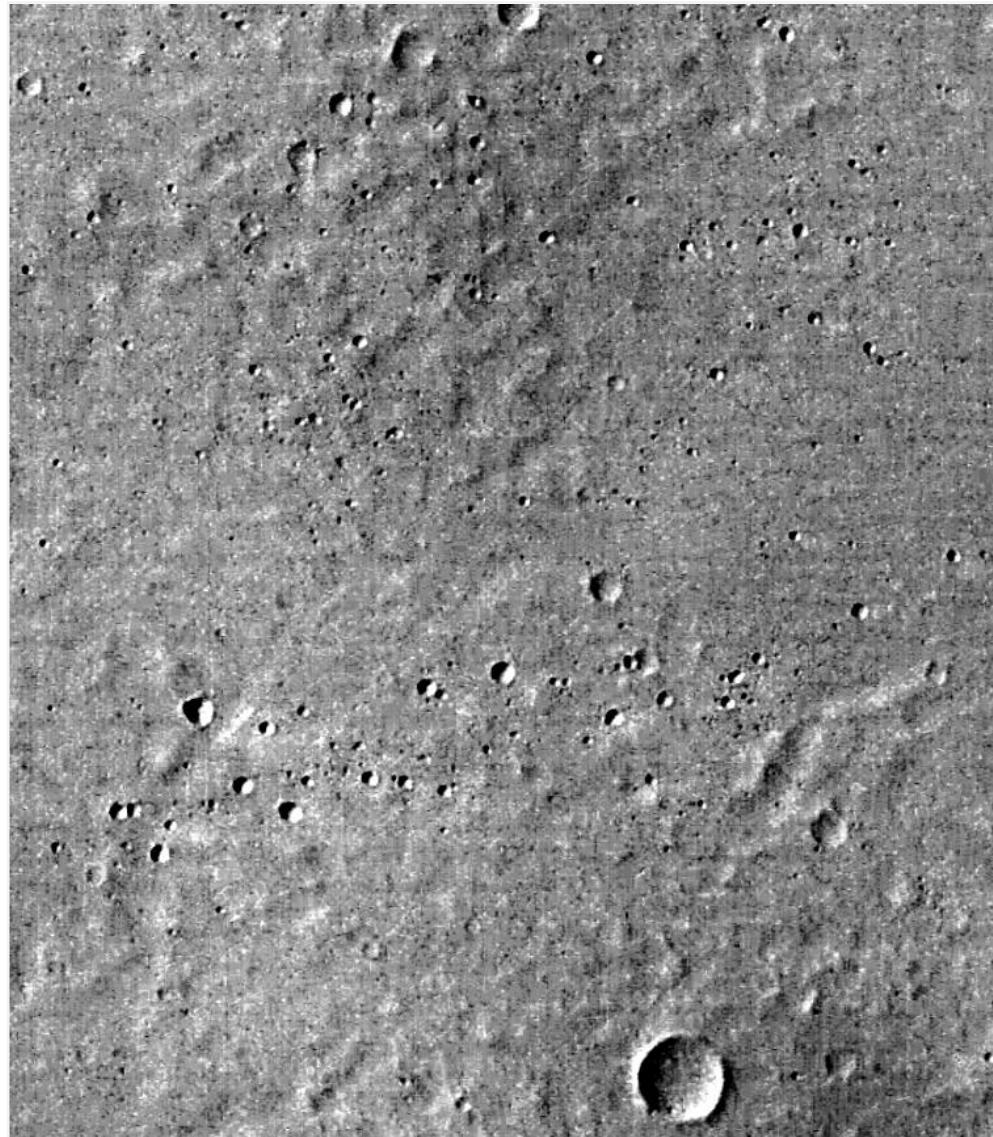


HRSC orbit 3283

Mapping a Counting Area



- separate geol./geomorph. units
- don't select steeply inclined surface, i.e. hillsides etc.
=> erosion/coverage of craters due to mass transport
- homogenous texture
- avoid rough surfaces
- exclude secondary crater clusters
- Do NOT count in areas like this one!



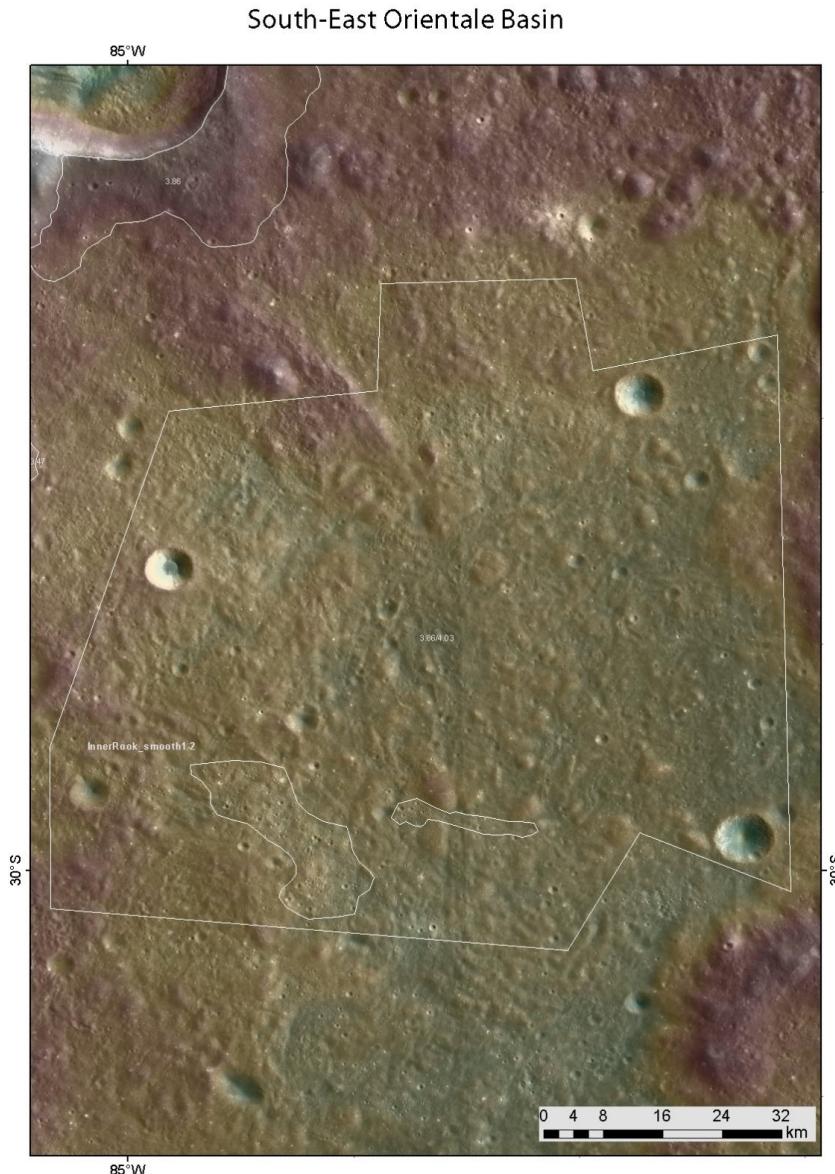
HRSC orbit 3283

Mapping a Counting Area



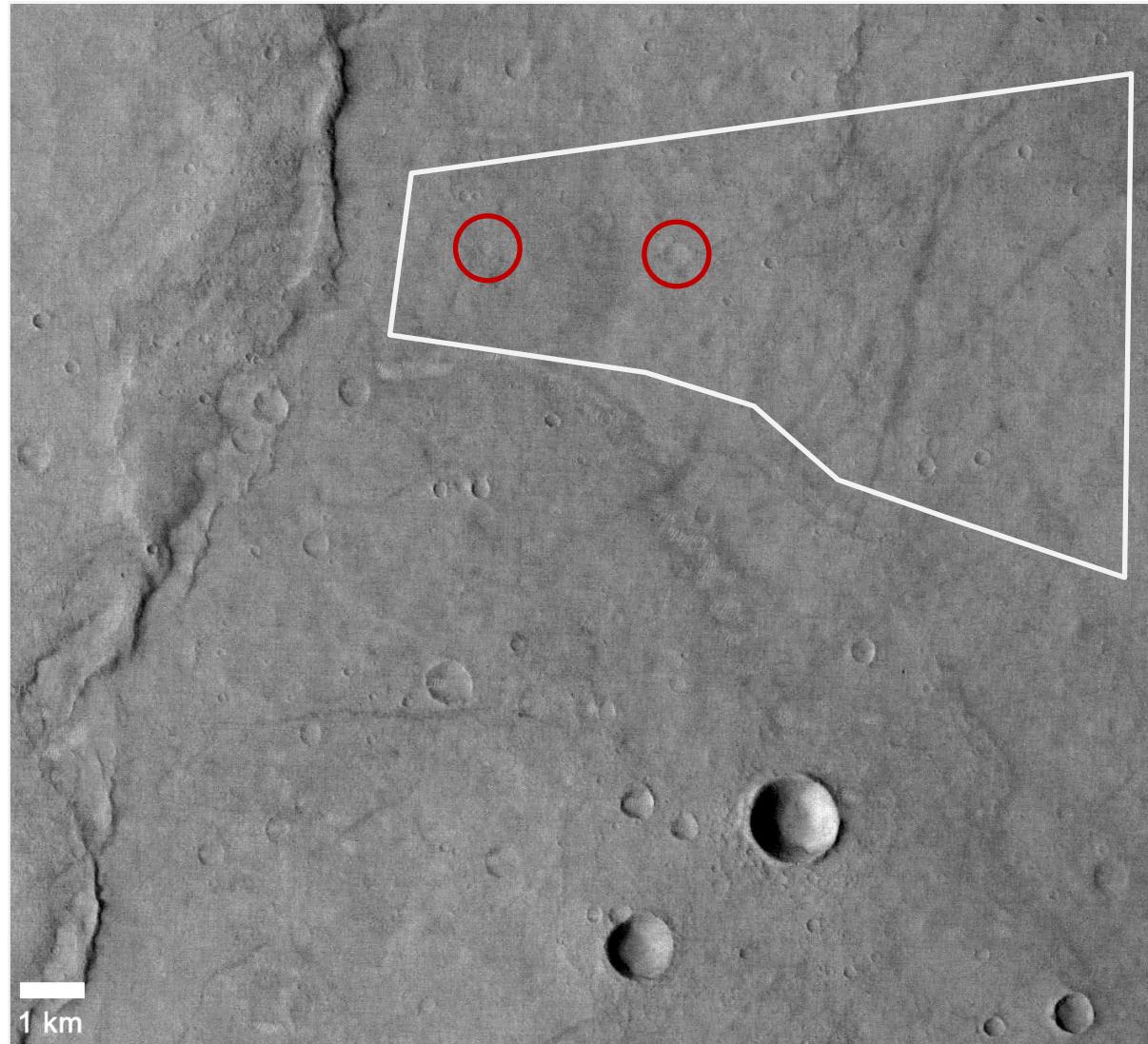
Minimum area size => good question

Define your counting area without paying attention to the presence of larger craters!





- define counting area
- measure **ALL** craters irrespective of erosional state
- NO crater classes

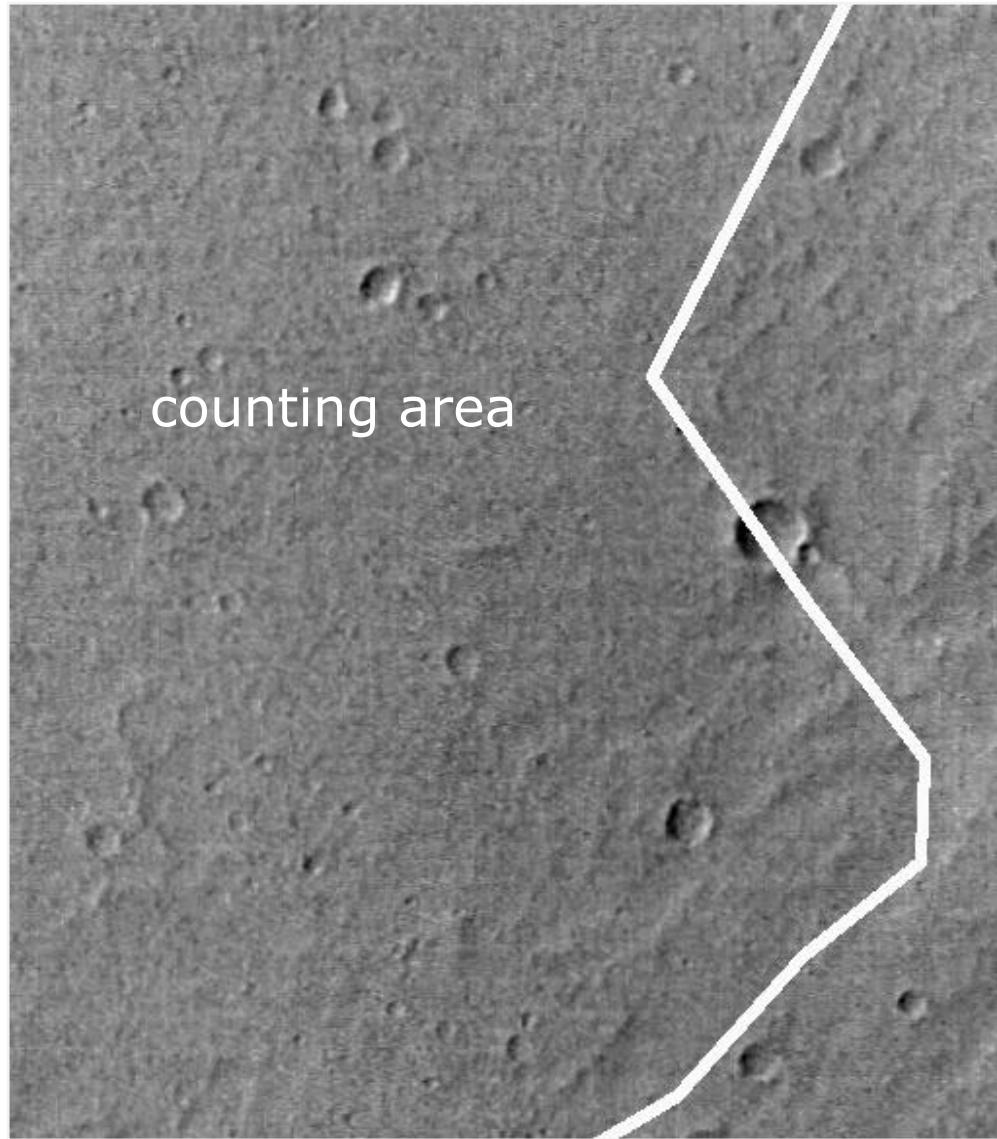


HRSC orbit 4248

1 km

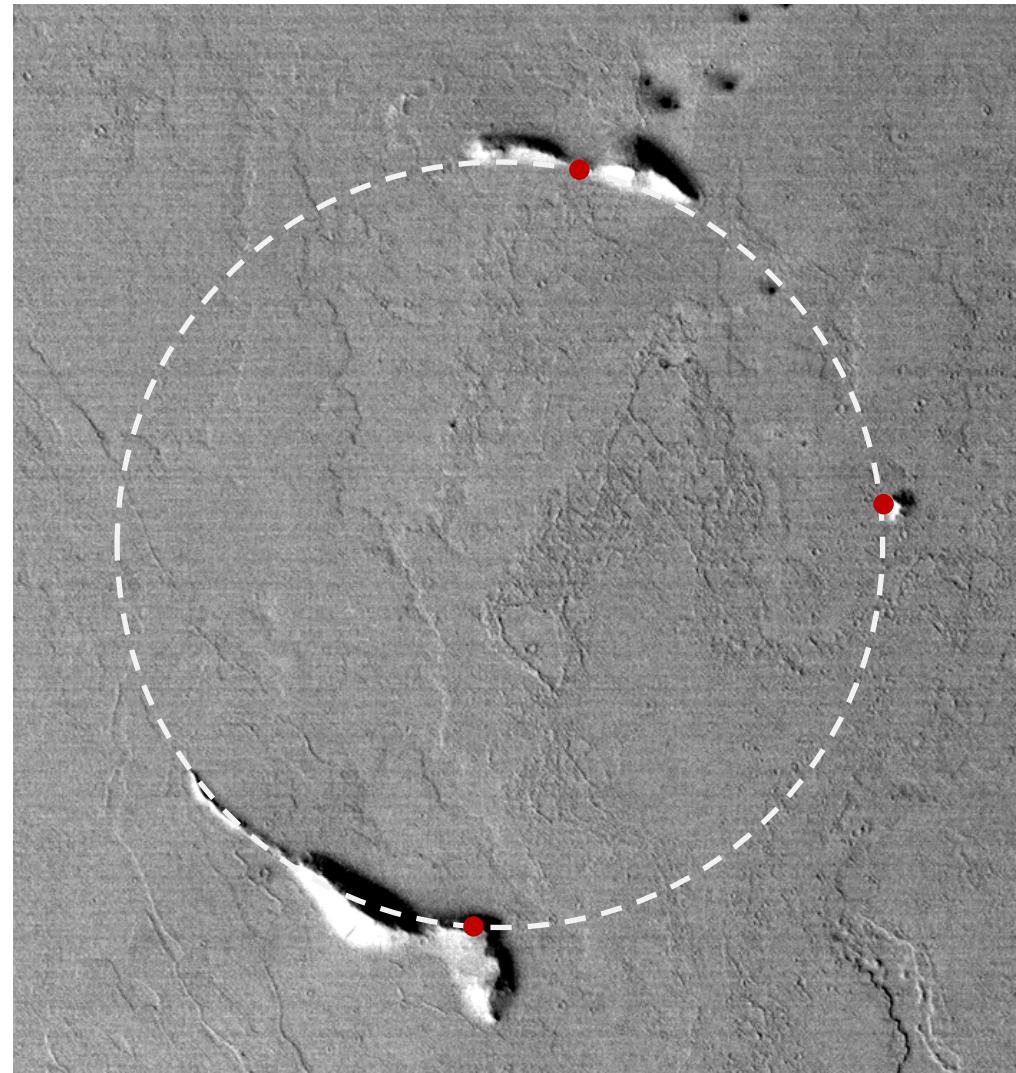


- define counting area
- measure ALL craters irrespective of erosional state
- NO crater classes
- Count all craters intersecting the counting area



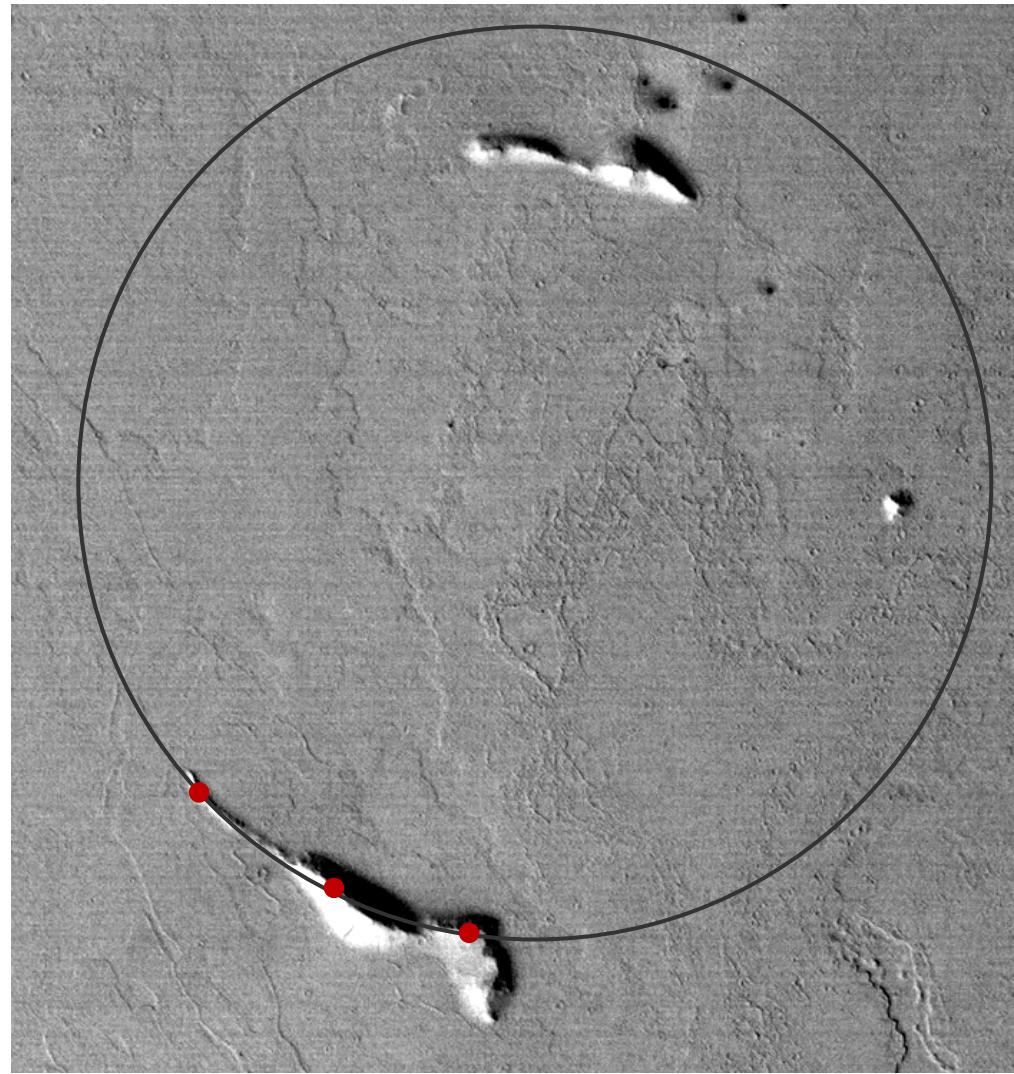


Buried craters



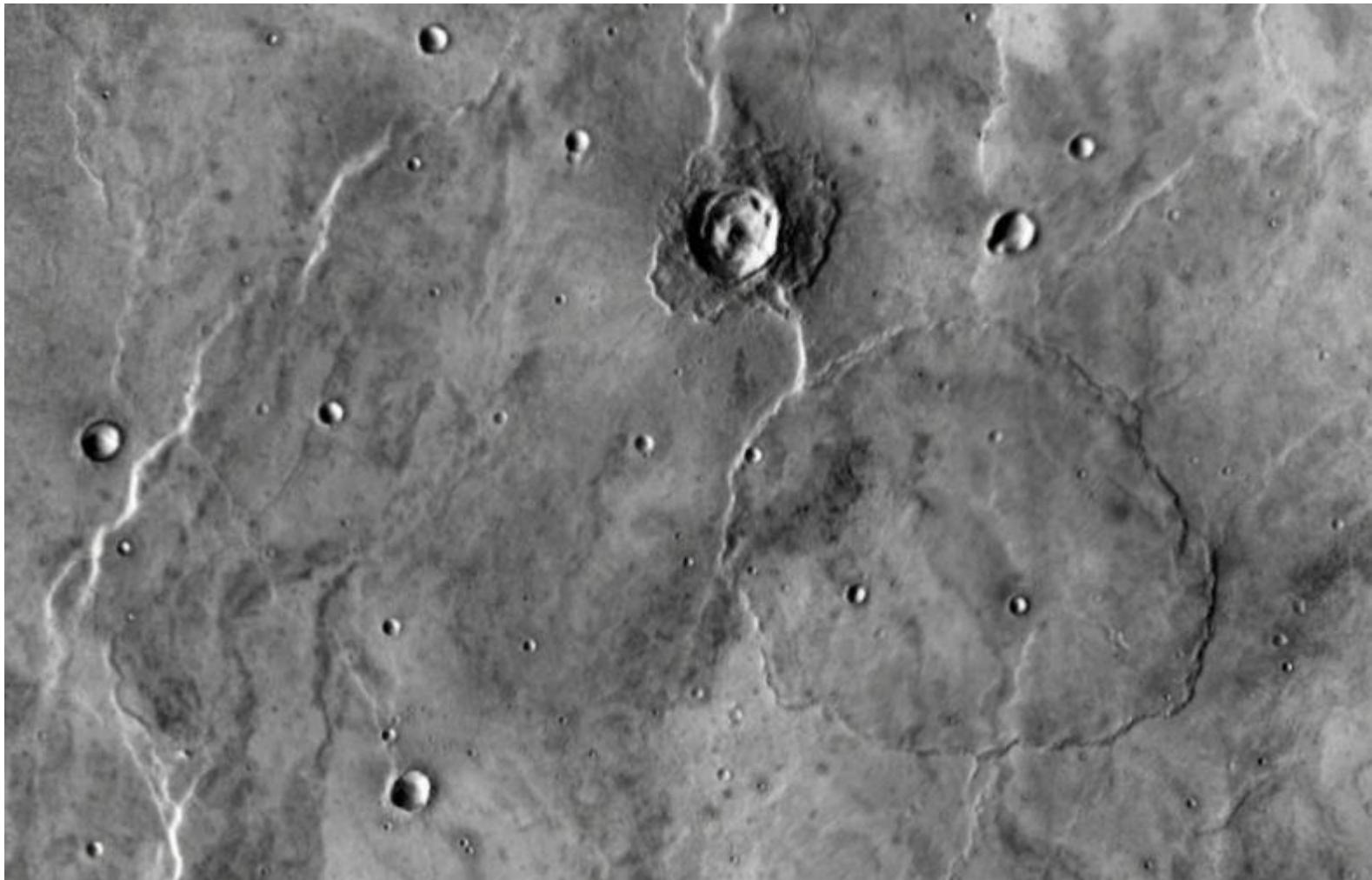


Buried craters



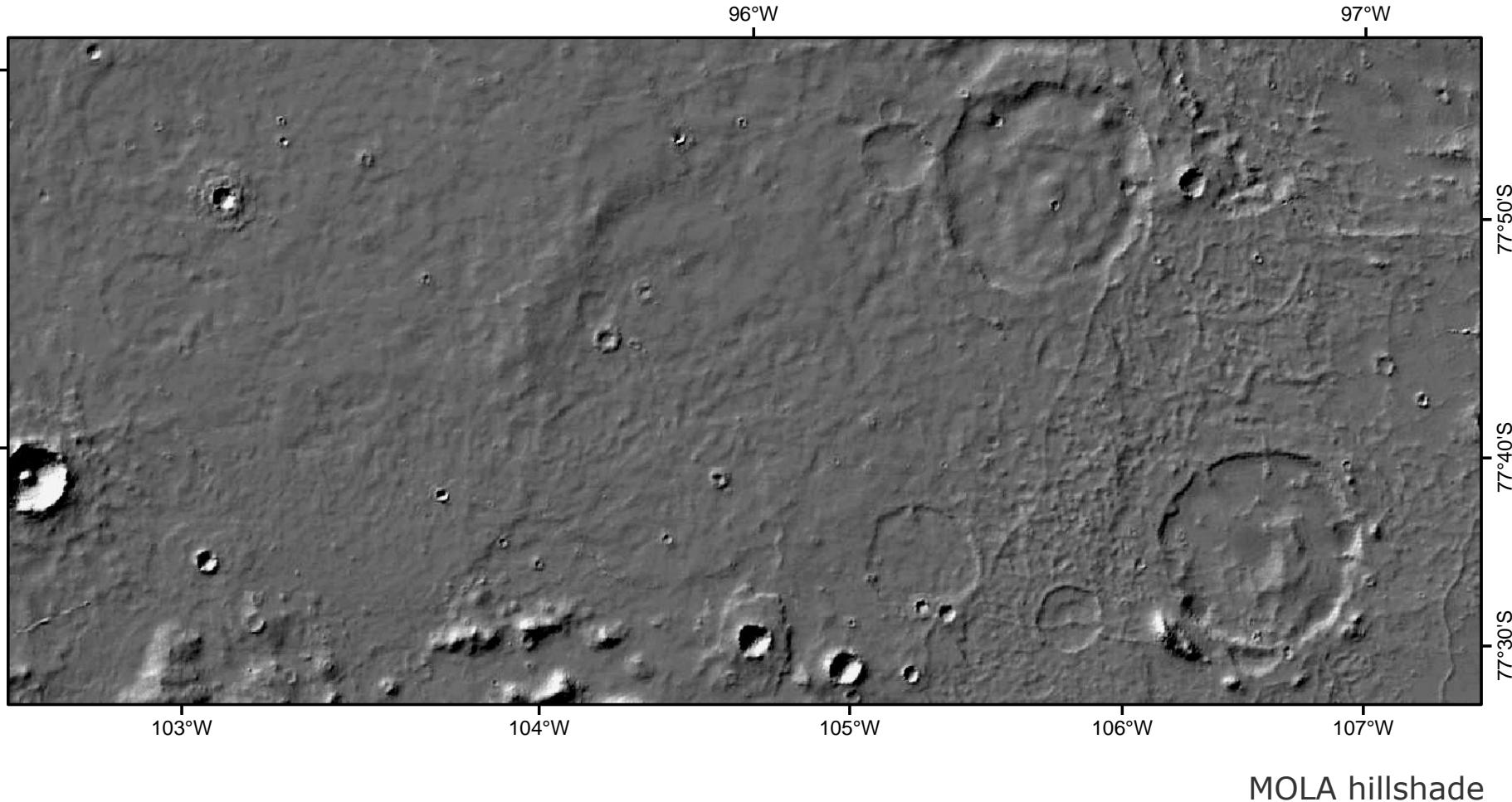


Ghost craters





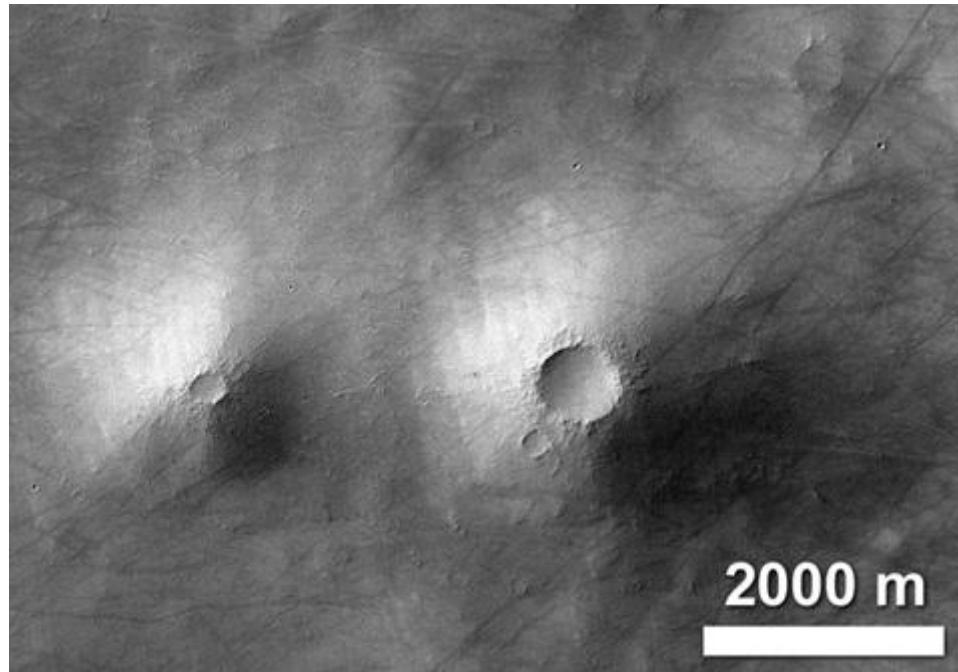
Ghost craters





**Caution – not every
near-circular feature
is an impact crater!!**

- volcanic craters

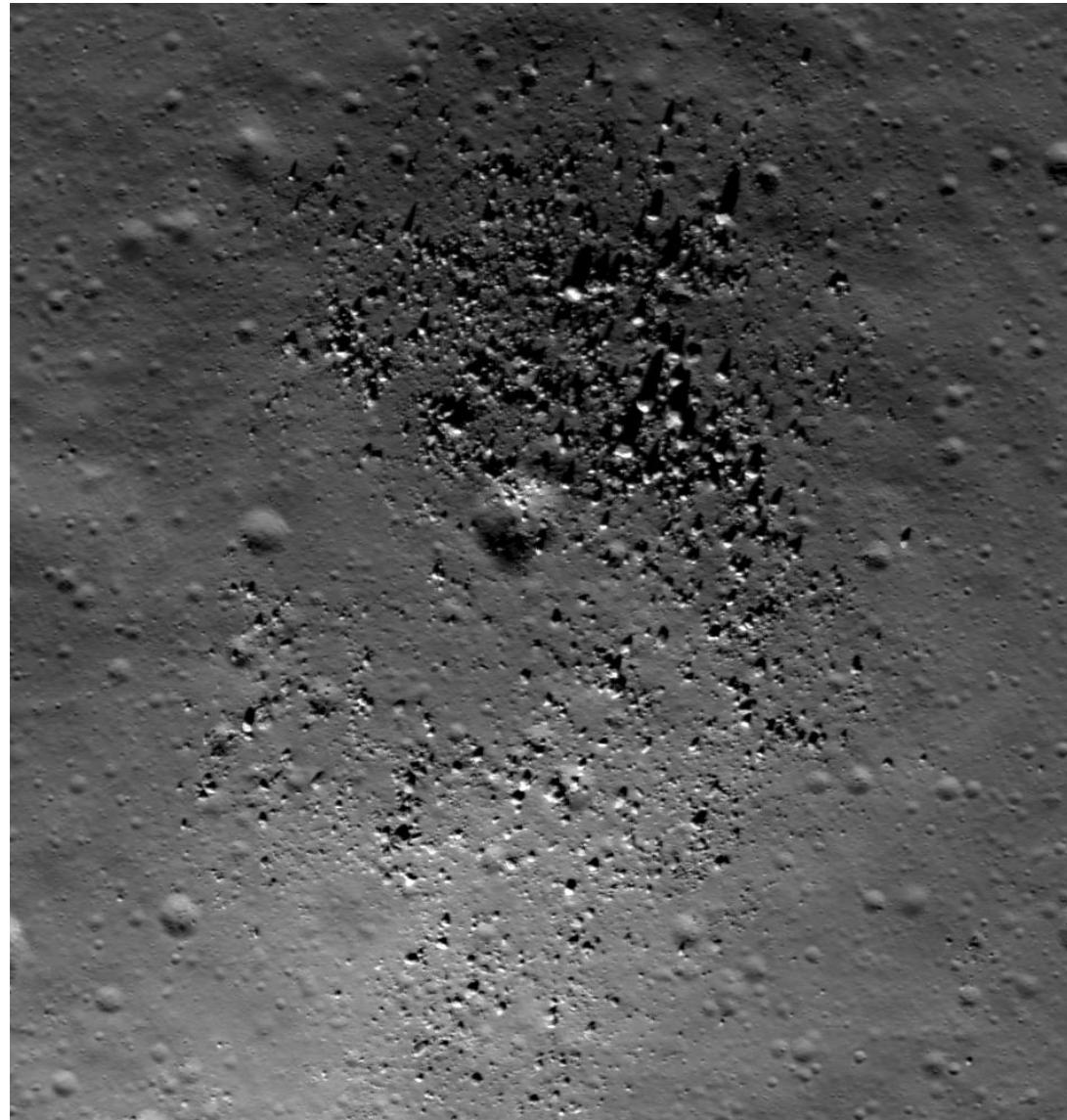


Hauber et al. (2009)



**Caution – not every
near-circular feature
is an impact crater!!**

- volcanic craters
- volcanic edifices

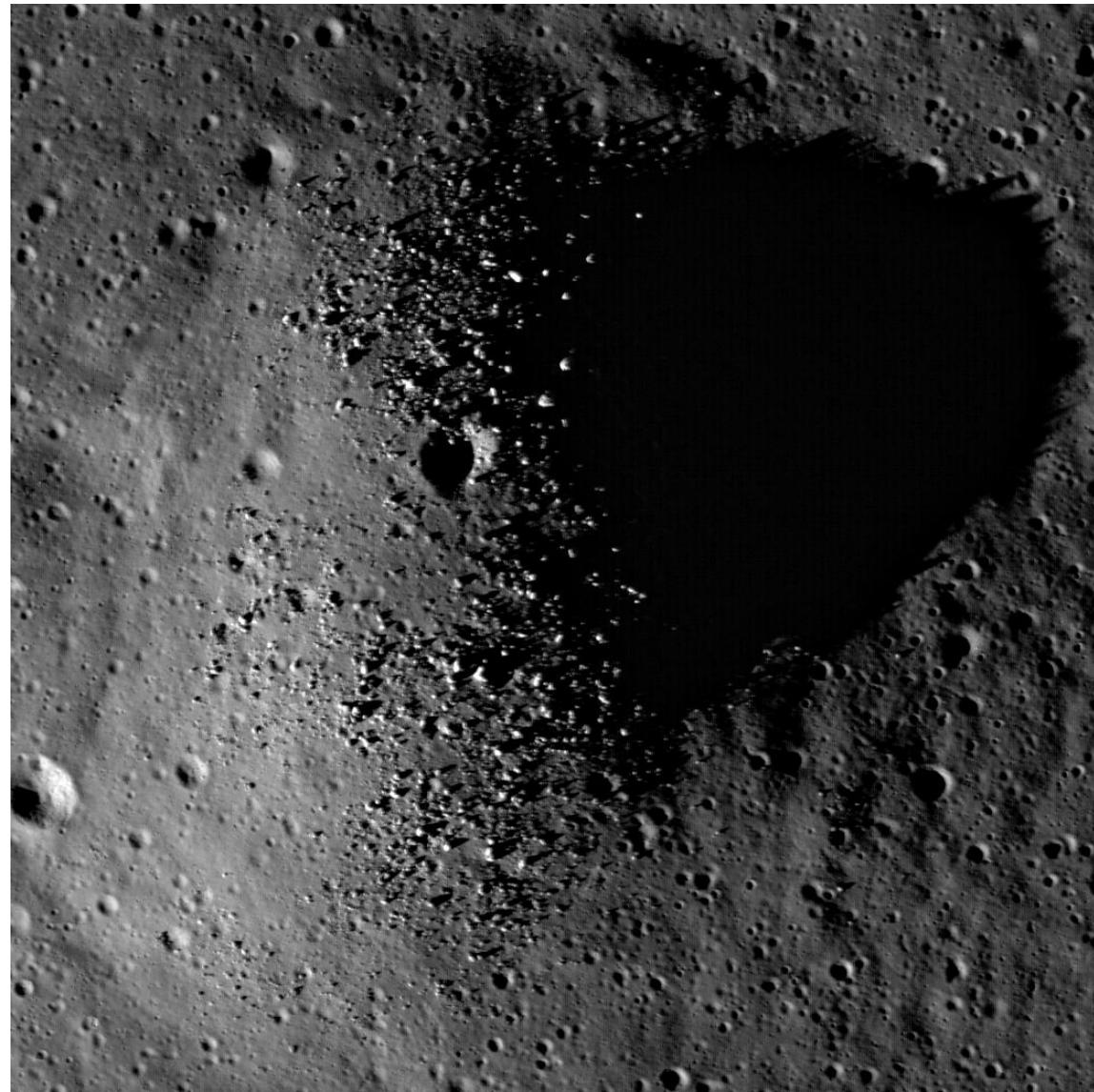


NAC M139238146L



**Caution – not every
near-circular feature
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- volcanic craters
- volcanic edifices

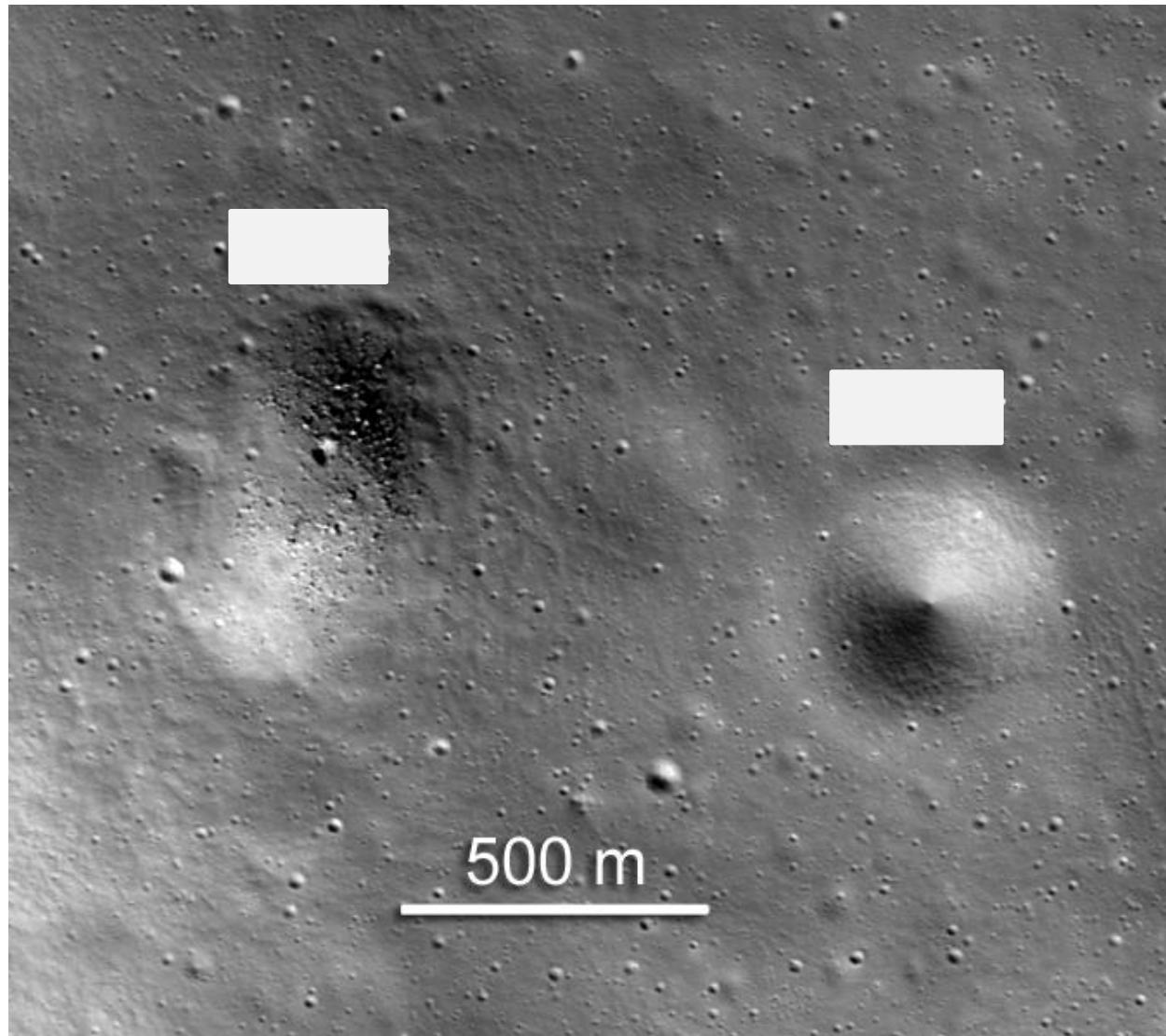


NAC M119198897R



**Caution – not every
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- volcanic craters
- volcanic edifices

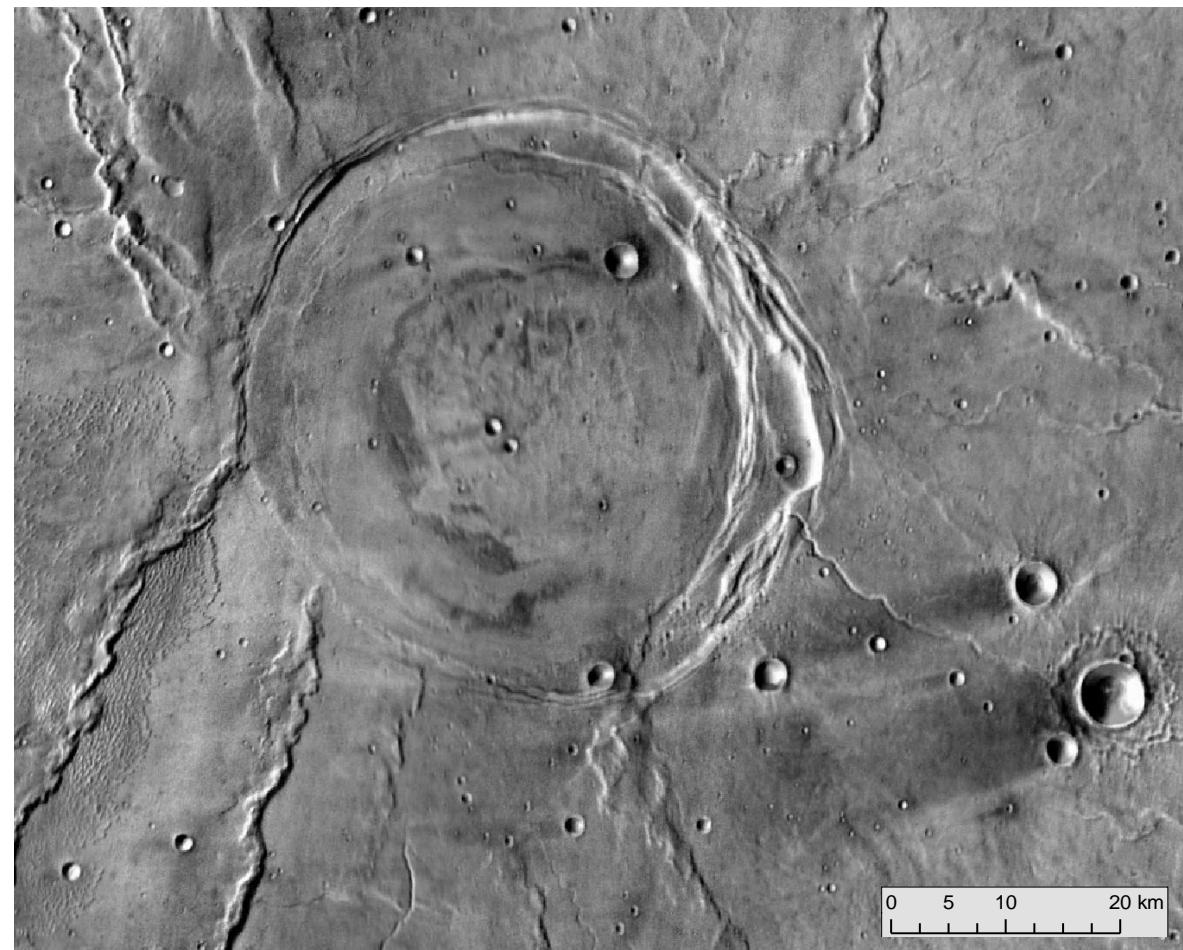


NAC M139238146L



**Caution – not every
near-circular feature
is an impact crater!!**

- volcanic craters
- volcanic edifices
- calderas



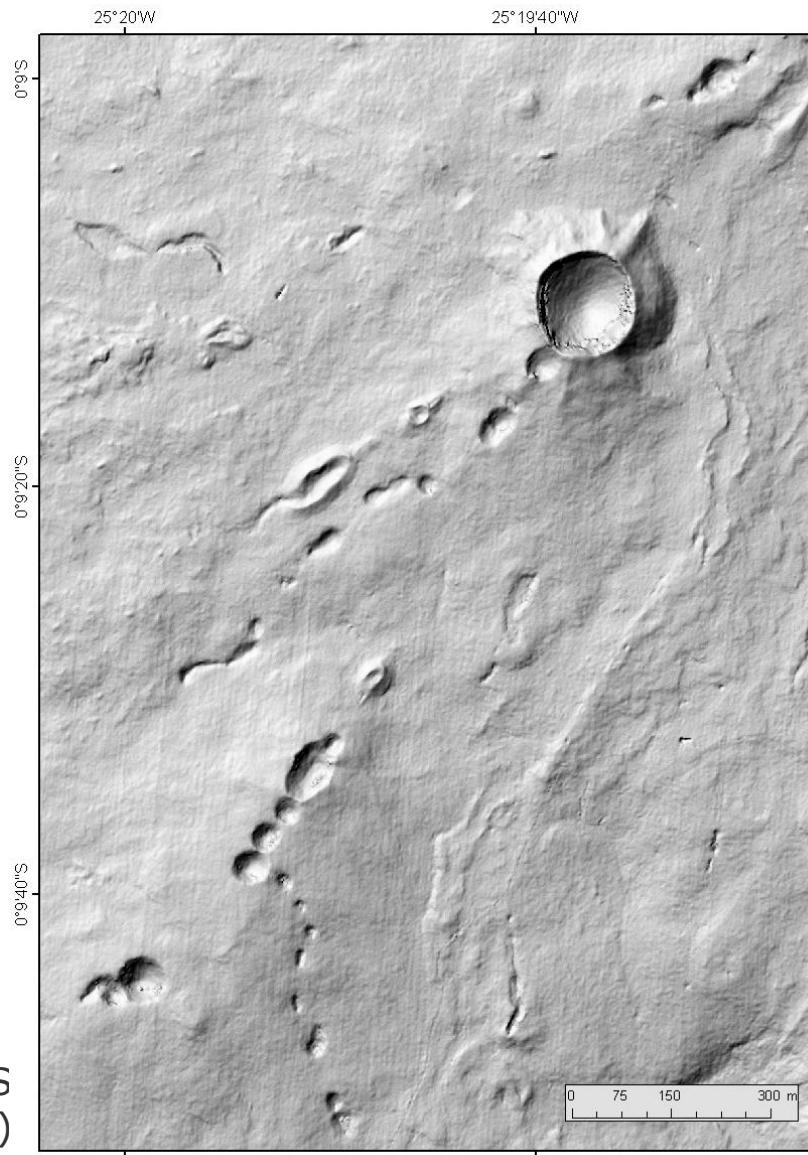
Meroe Patera, Mars (THEMIS IR day)



**Caution – not every
near-circular feature
is an impact crater!!**

- volcanic craters
- volcanic edifices
- calderas
- collapsed lava tubes

Western Volcanic Zone, IS
(HRSC-AX hillshade)

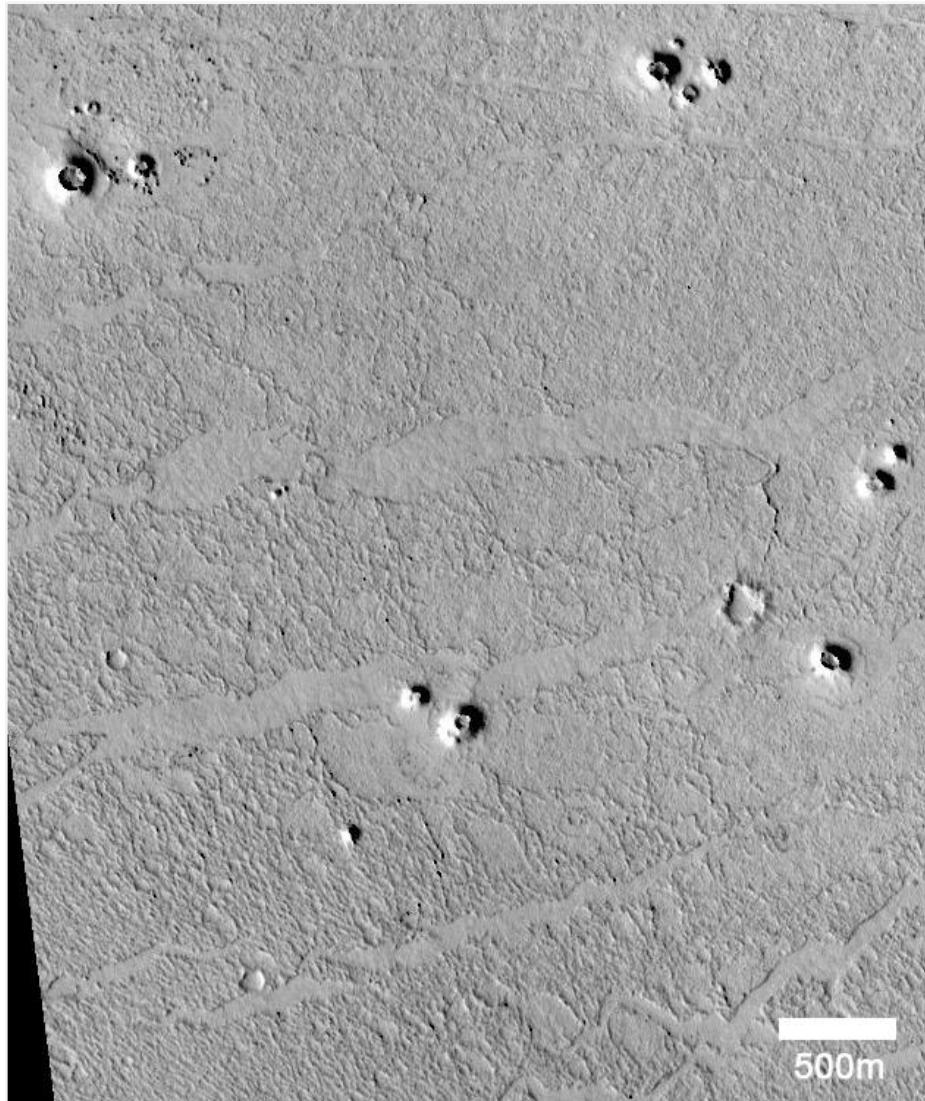




**Caution – not every
near-circular feature
is an impact crater!!**

- volcanic craters
- volcanic edifices
- calderas
- collapsed lava tubes
- pseudo craters

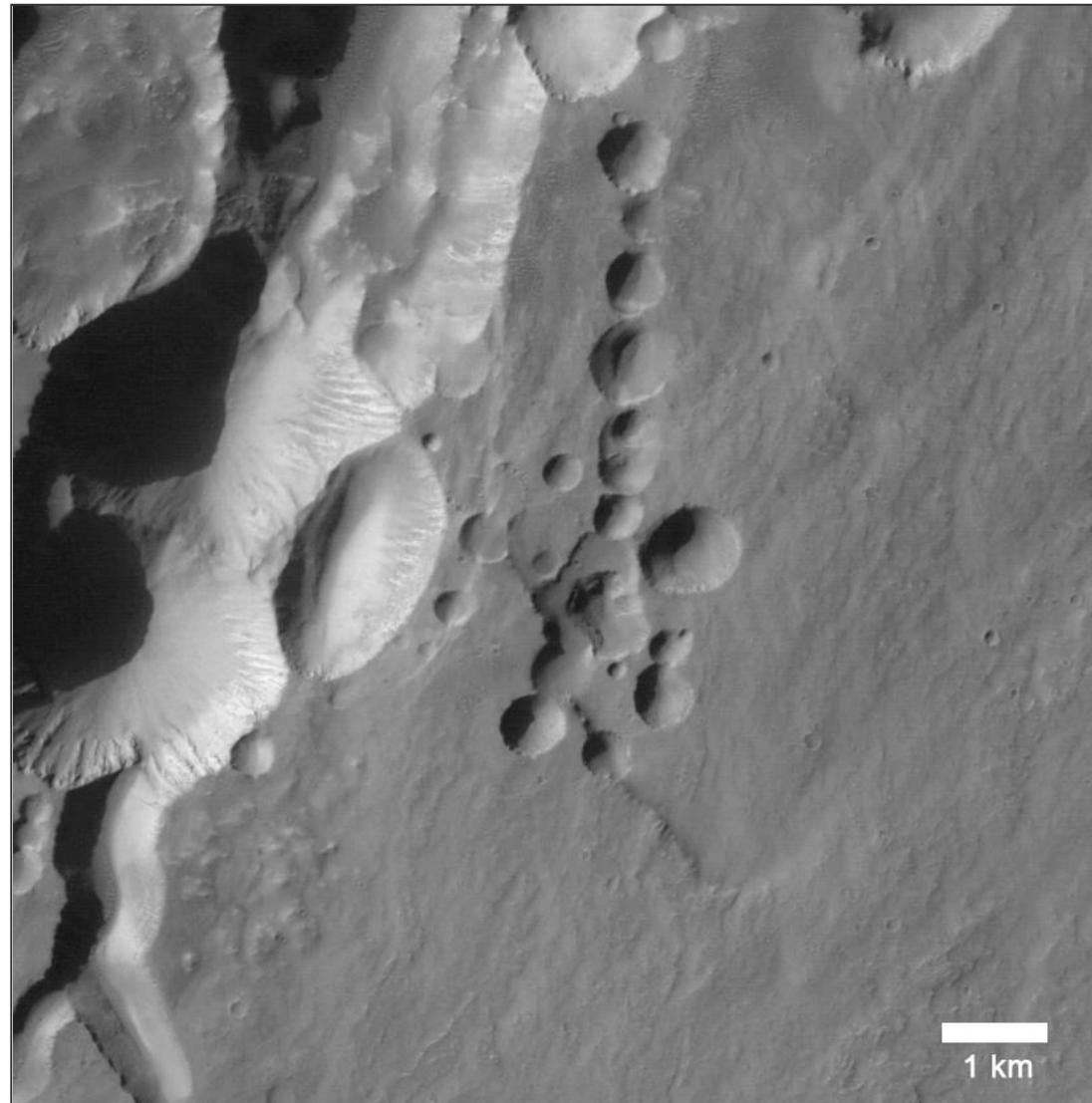
MOC M0303958





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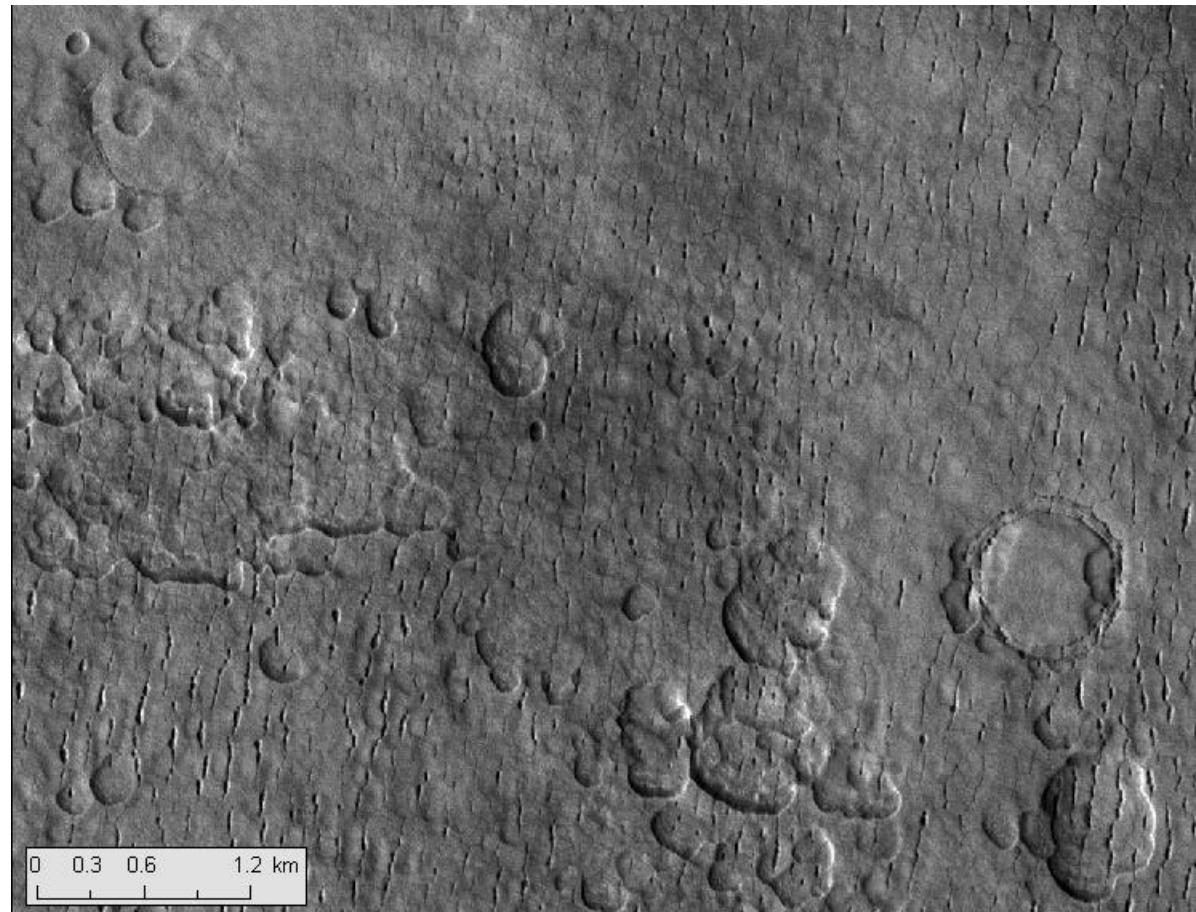
- volcanic craters
- volcanic edifices
- calderas
- collapsed lava tubes
- pseudo craters
- pit craters





**Caution – not every
near-circular feature
is an impact crater!!**

- volcanic craters
- volcanic edifices
- calderas
- collapsed lava tubes
- pseudo craters
- pit craters
- thermokarst



CTX P03_002202_2249_XN_44N275W



- Select representative area of a mapped unit for crater counting
 - Mapping area ≠ counting area
 - Counting area must not cross unit boundaries
 - Review crater counts by modifying the imagery
 - Check crater counts by utilising multiple datasets
- => Now the time has come to export your crater counts

If there appears to be something funny going on

- => consult your colleagues
- => consult FU Berlin