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

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Outline

- 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
Preparation of Raster Datasets


Sinusoidal Equal Area

Mercator

Lambert Azimuthal Equal Area
Preparation of Raster Datasets

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


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

Equidistant-cylindrical

72°N

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)
Mapping of Surface Units

- 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
Mapping of Surface Units

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

MOLA DTM on THEMIS IR day; 100 m/px

Simud Valles
Mapping of Surface Units

THEMIS IR day; 100 m/px

THEMIS IR night; 100 m/px

Simud Valles
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

Simud Valles

CTX; 5.5 m/px

HiRISE; 0.25 m/px
Image Modification

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
Image Modification

Havel Vallis

Image processing => misinterpretations due to enhancement of noise and artefacts possible

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.
Mapping a Counting Area

Only homogeneous areas!

LROC, WAC, Moon (S32°/E146°)
Image artefacts can affect crater SFDs.
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
• 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
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

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
Minimum area size => good question

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

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

HRSC orbit 4248
Crater Counting

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

Buried craters
Crater Counting

Buried craters
Ghost craters

THEMIS IR day
Ghost craters

MOLA hillshade
Crater Counting

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

• volcanic craters

Hauber et al. (2009)
Crater Counting

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

• volcanic craters
• volcanic edifices

NAC M139238146L
Crater Counting

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

- volcanic craters
- volcanic edifices

NAC M119198897R
Caution – not every near-circular feature is an impact crater!!

• volcanic craters
• volcanic edifices
Crater Counting

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

- volcanic craters
- volcanic edifices
- calderas

Meroe Patera, Mars (THEMIS IR day)
Crater Counting

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

- 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
Conclusions

- 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