Craters, resurfacing and Layers

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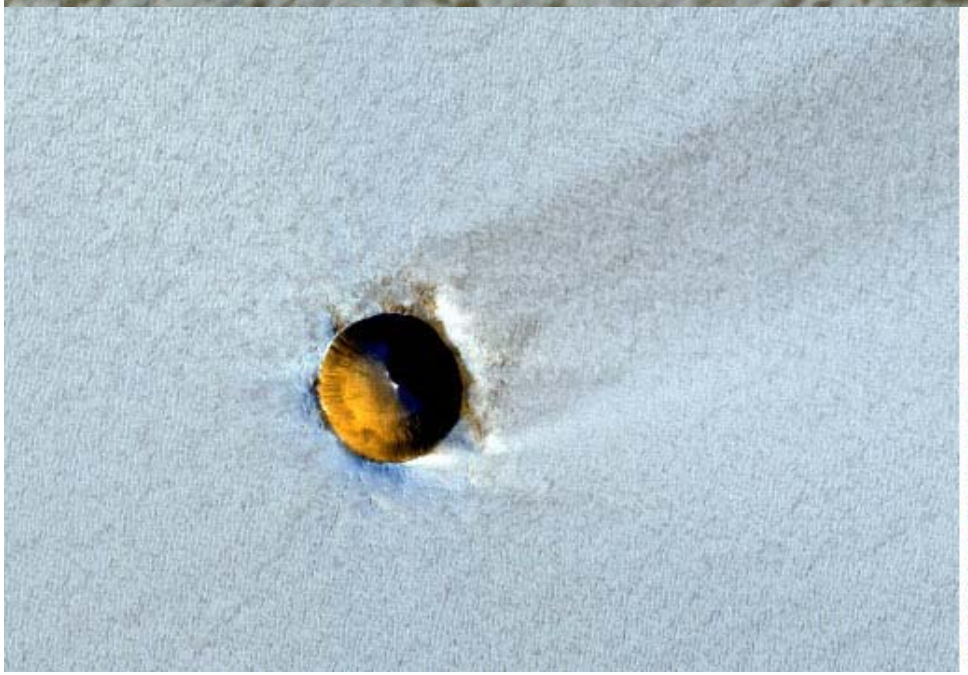
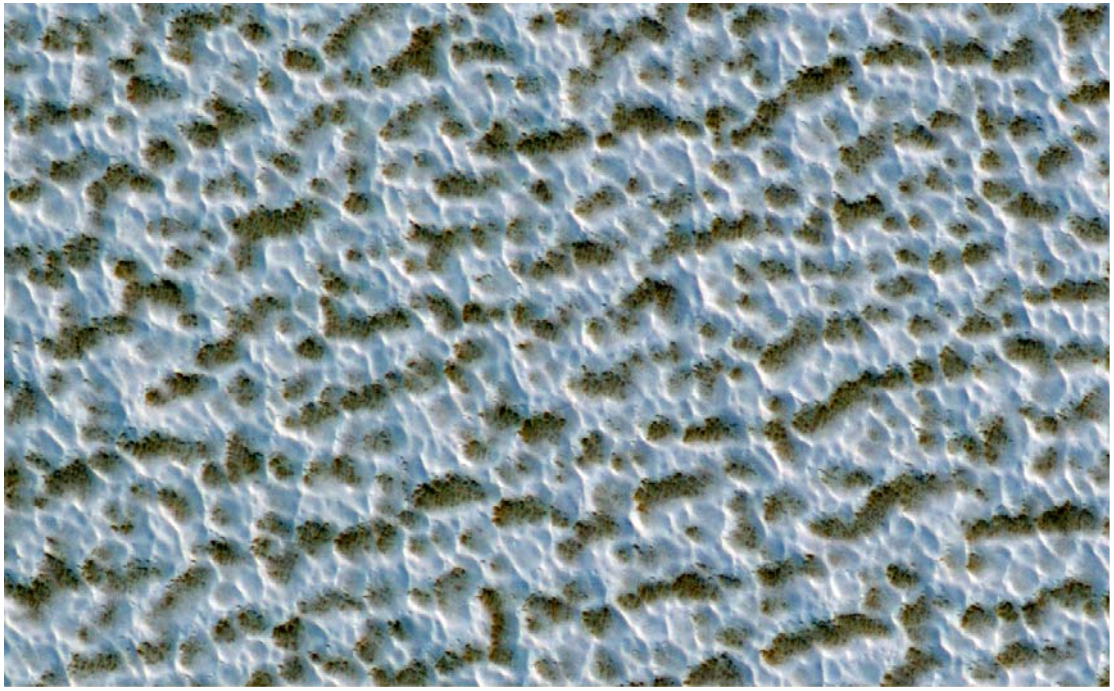
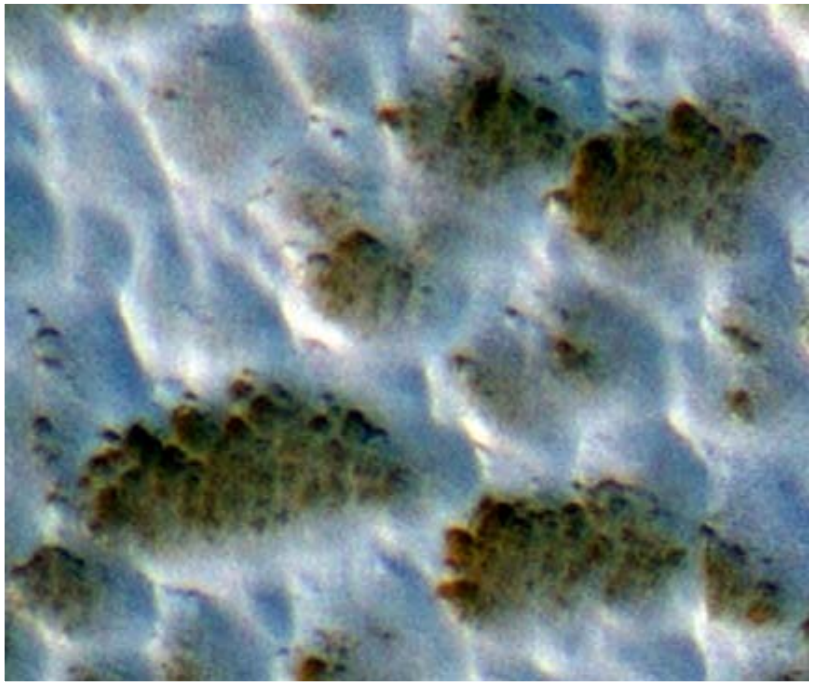
HiRISE



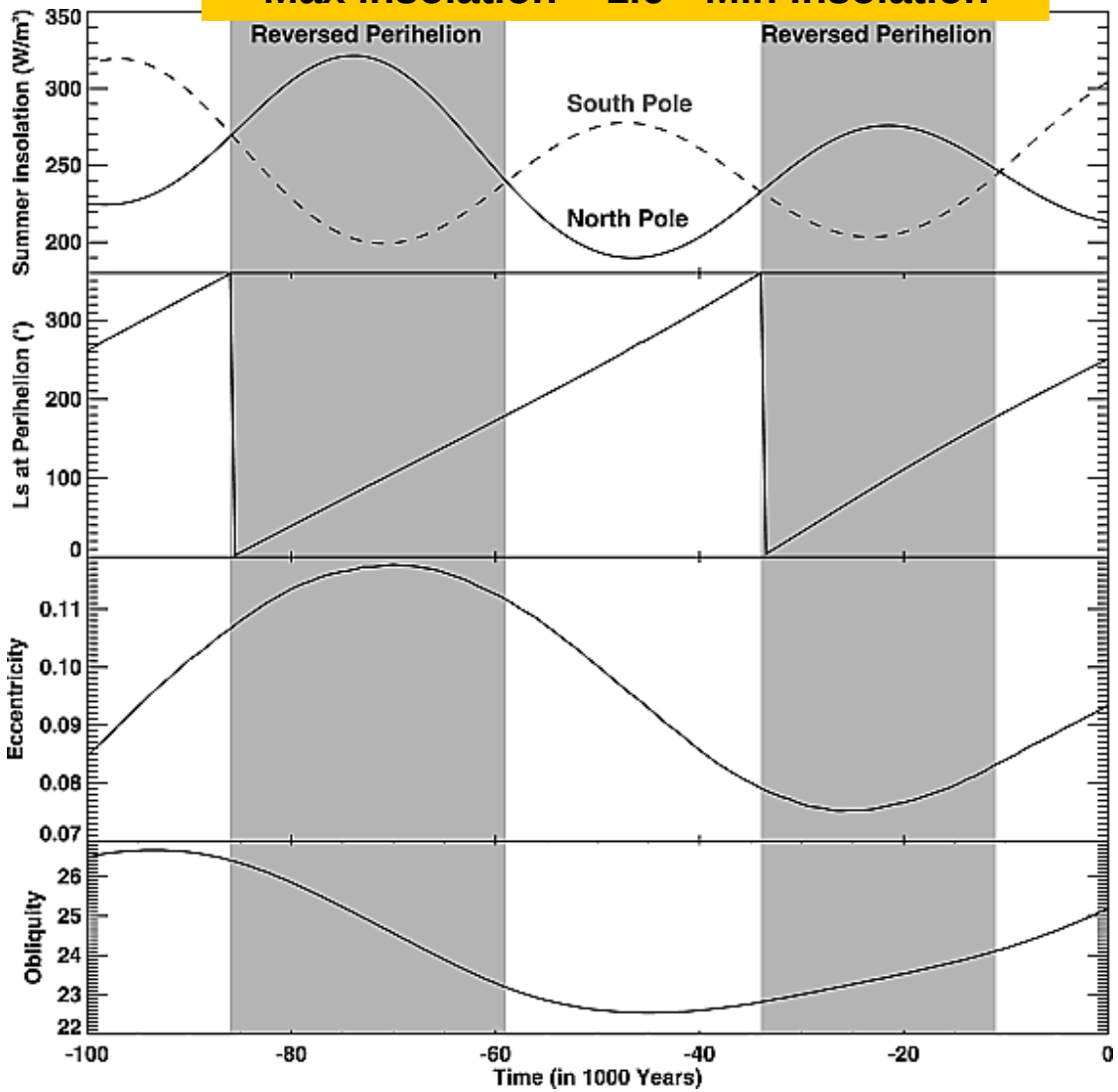
- **Can we understand present accumulation/loss rates?**
  - **Dust-free ice must have accumulated recently or is ongoing**
  - **OMEGA grain-sizes indicates current net loss**
  - **NRC has temporary variations in extent (~1%) - reversible**
  - **i.e. it's not clear what's going on…**





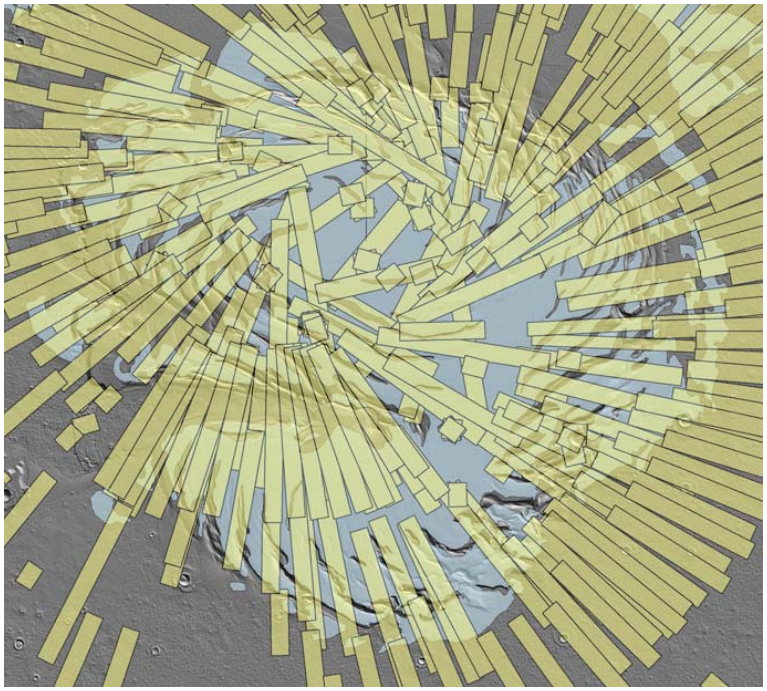
- **If we can figure out what's happening today…**
  - **Can we do that for the recent past (10s of Kyr)?**
  - **Can we do that for the distant past (100s to 1000s of Kyr)?**

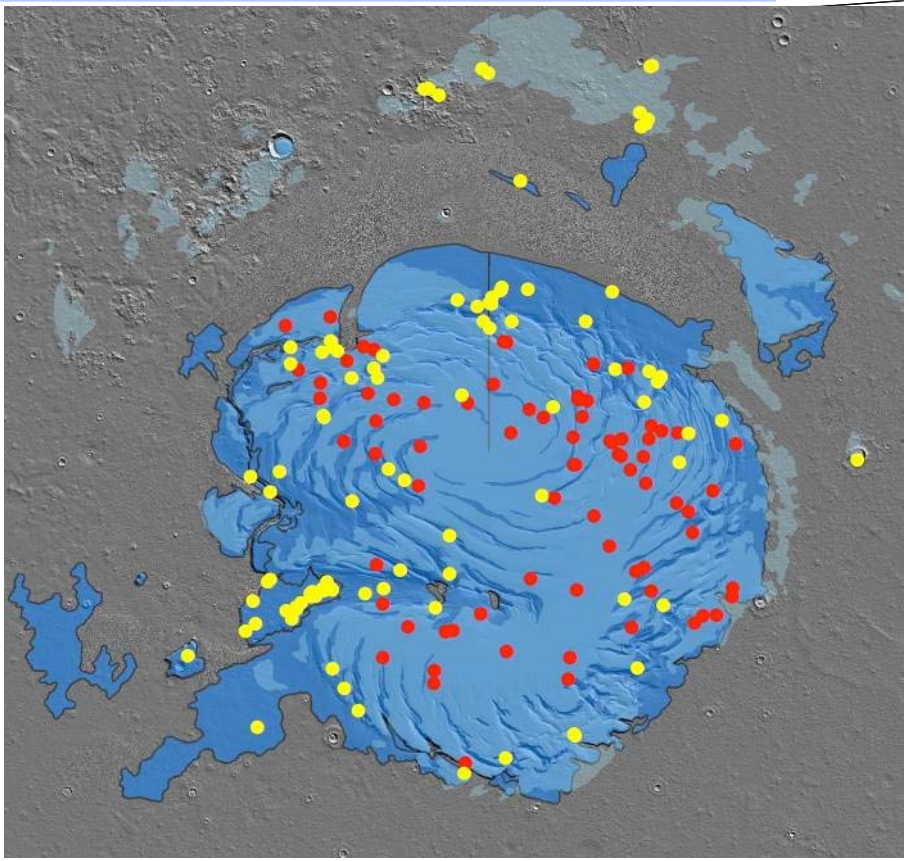
Max insolation ~ 1.6 * Min Insolation



Montmessin et al., JGR, 2007

Craters, Ablation and Layers

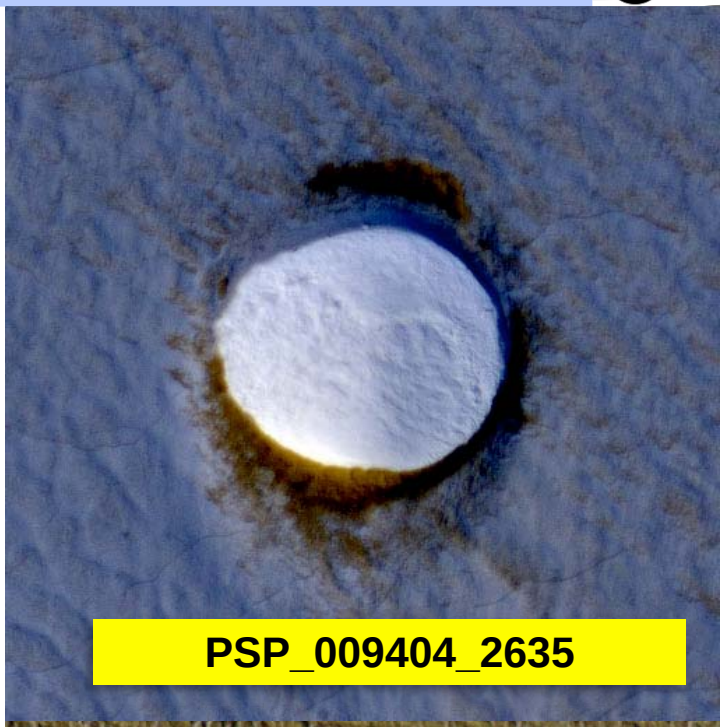




- **CTX search**
  - **188 craters**
- **HiRISE follow-up**
  - **Accurate sizes – focus on smaller craters**
  - **Morphologic sequence of degradation – focus on larger craters**
  - **78 craters on the NRC (red dots)**

Craters, Ablation and Layers

- **Interior of craters a site of net ice accumulation**
  - **Most of residual cap has old ice exposed (net ablation)**
  - **Some craters virtually ice free – younger?**
  - **d/D ~ 0.23 i.e. plenty of shadowing**
    - **Kick-starts a positive accumulation feedback**



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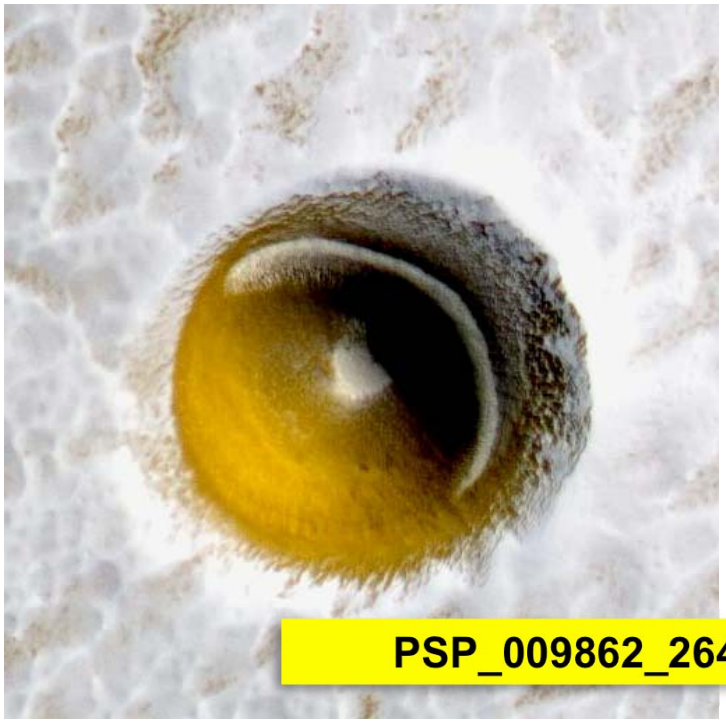

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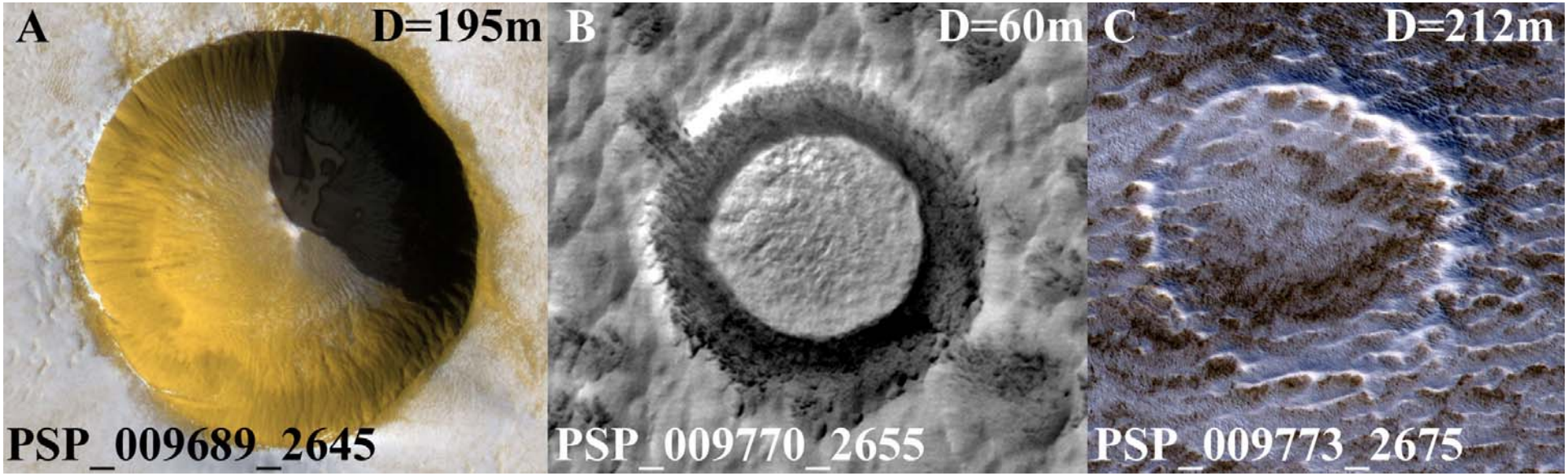
Craters, Ablation and Layers

- **Morphologic sequence**
  - **Craters fill with ice**
  - **Ablation features (sun cups) chop up the rims**

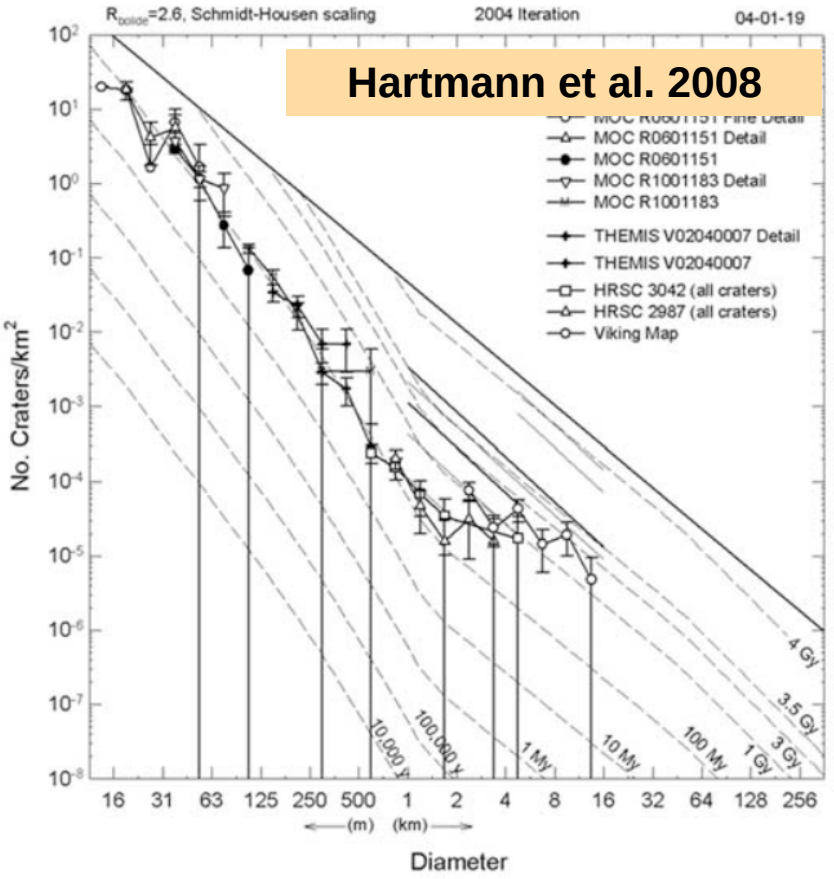


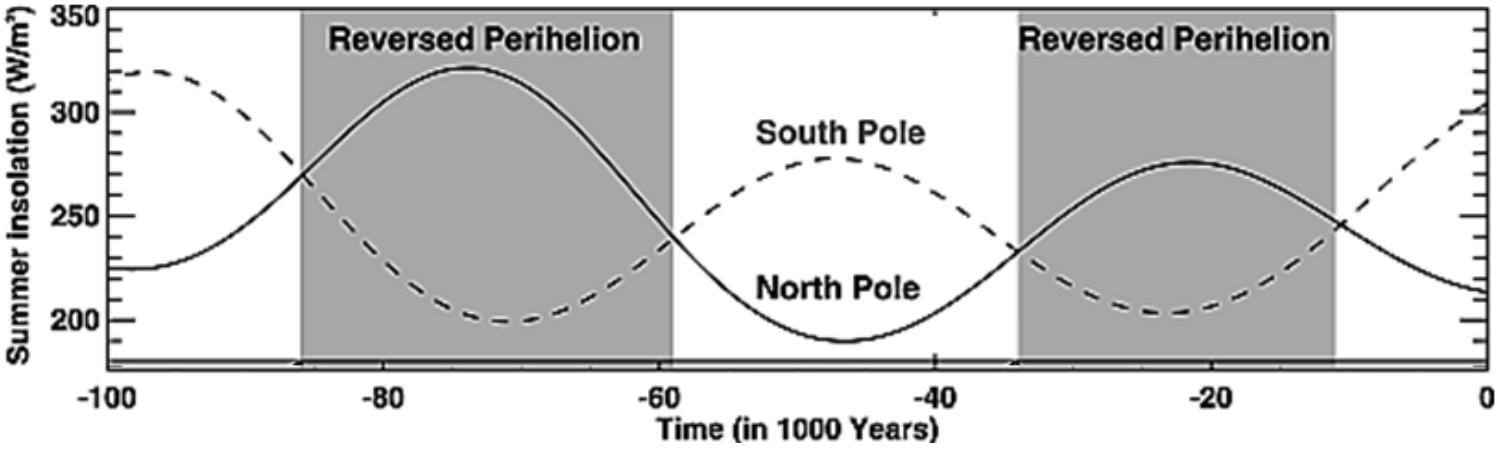
- **What do we learn from the crater population?**
- **What do we learn from the individual craters?**

Craters, Ablation and Layers

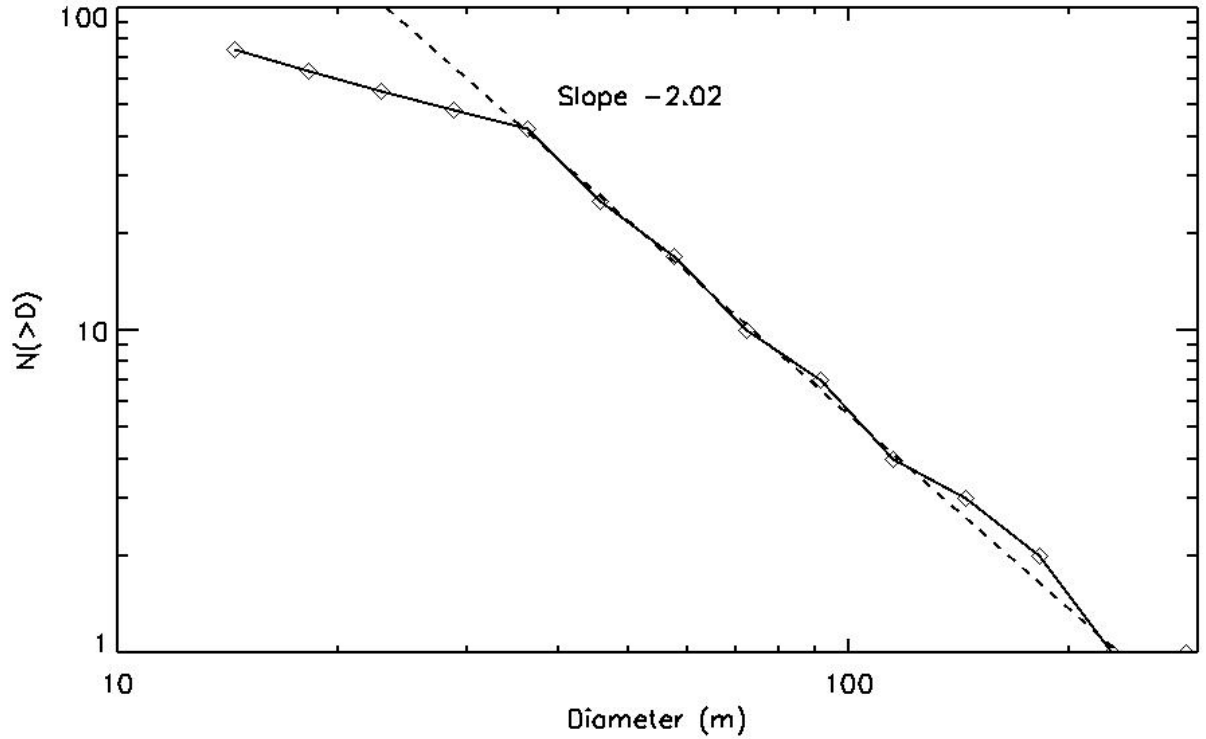
- **Hartmann isochrons**
  - Slope about -3.05 predicted from lunar work
  - A 250m crater (210-297m bin) should form on the NRC every ~10 Kyr

- **Krevlavsky counts**
  - Zunil eject blanket
  - Shows -2.85 slope
  - Agrees with Hartman and Neukum when D>10m

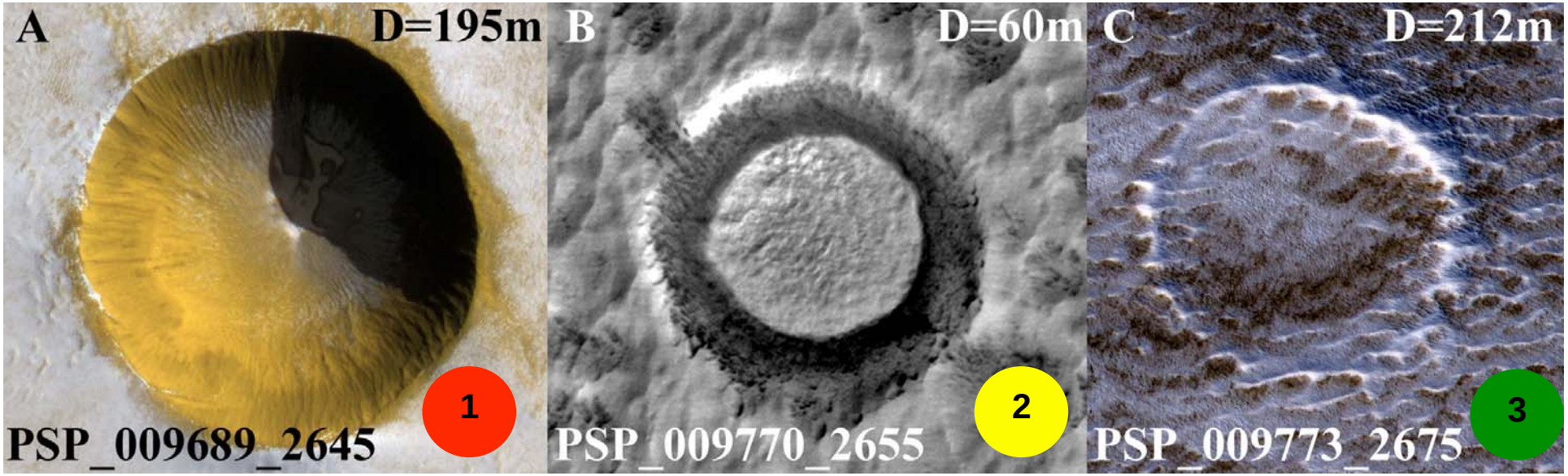




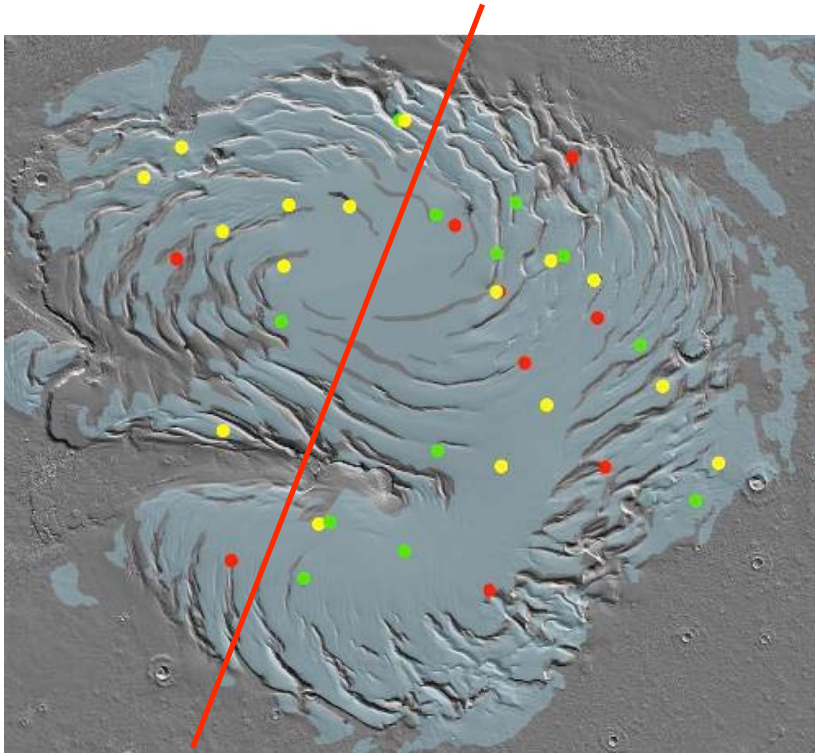
- **SFD has an uncertain slope**
  - **Depends on where you start the bin boundaries**
  - **Slope is -2.02**
- **Well above the -3.05 production slope**
  - **Misha's work validates the Hartman slope**
  - **An equilibrium population – also consistent with morphologic sequence**
- **Crater lifetime proportional to $D^{1.03}$**



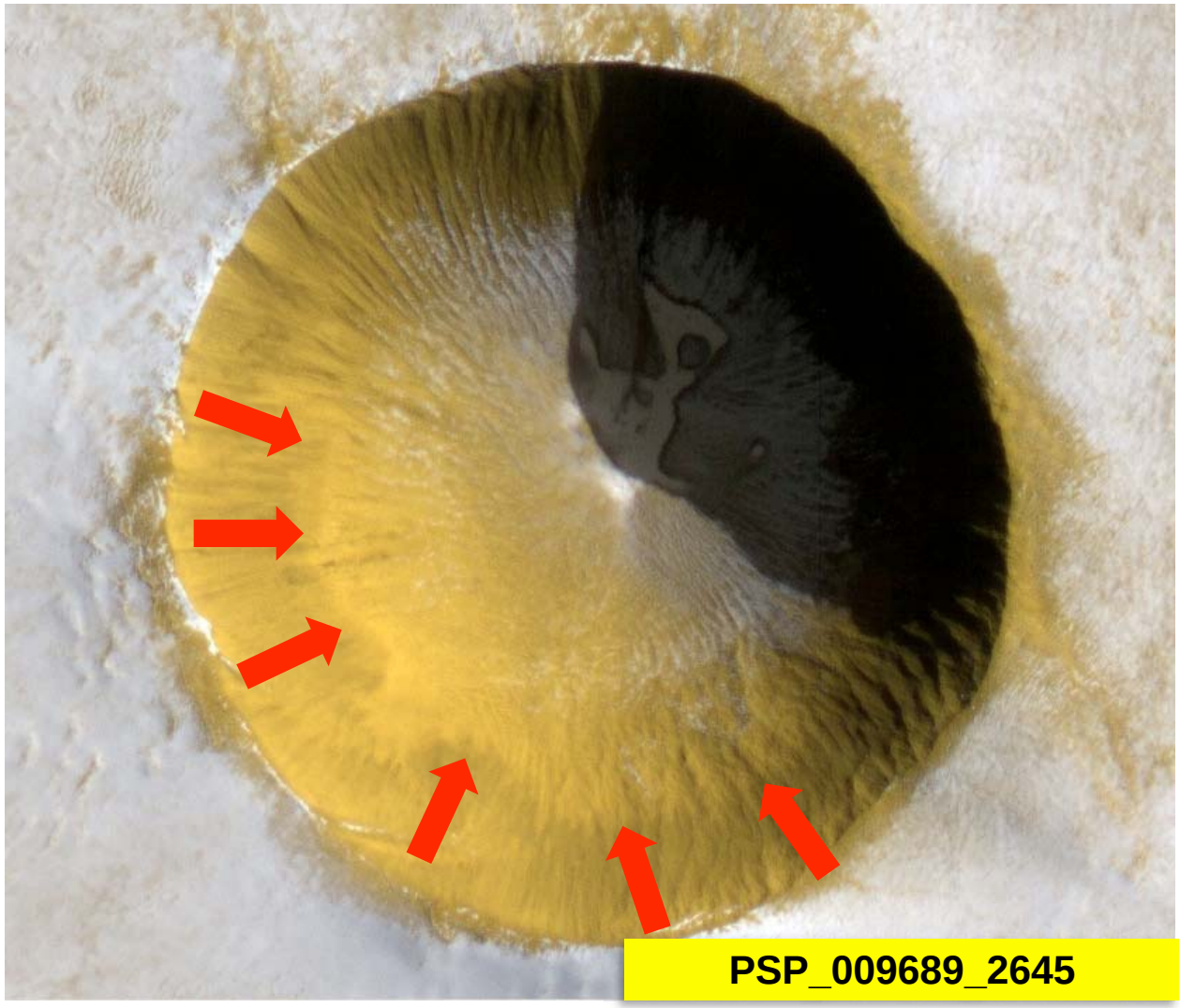
Craters, Ablation and Layers



- **Degradation as a function of location**
  - **Longitudinal asymmetry?**
  - **No latitudinal pattern**
  - **Similar to elevation asymmetry**
  - **Atmospheric pattern…**
  - **Water vapor availability from surrounding regolith**

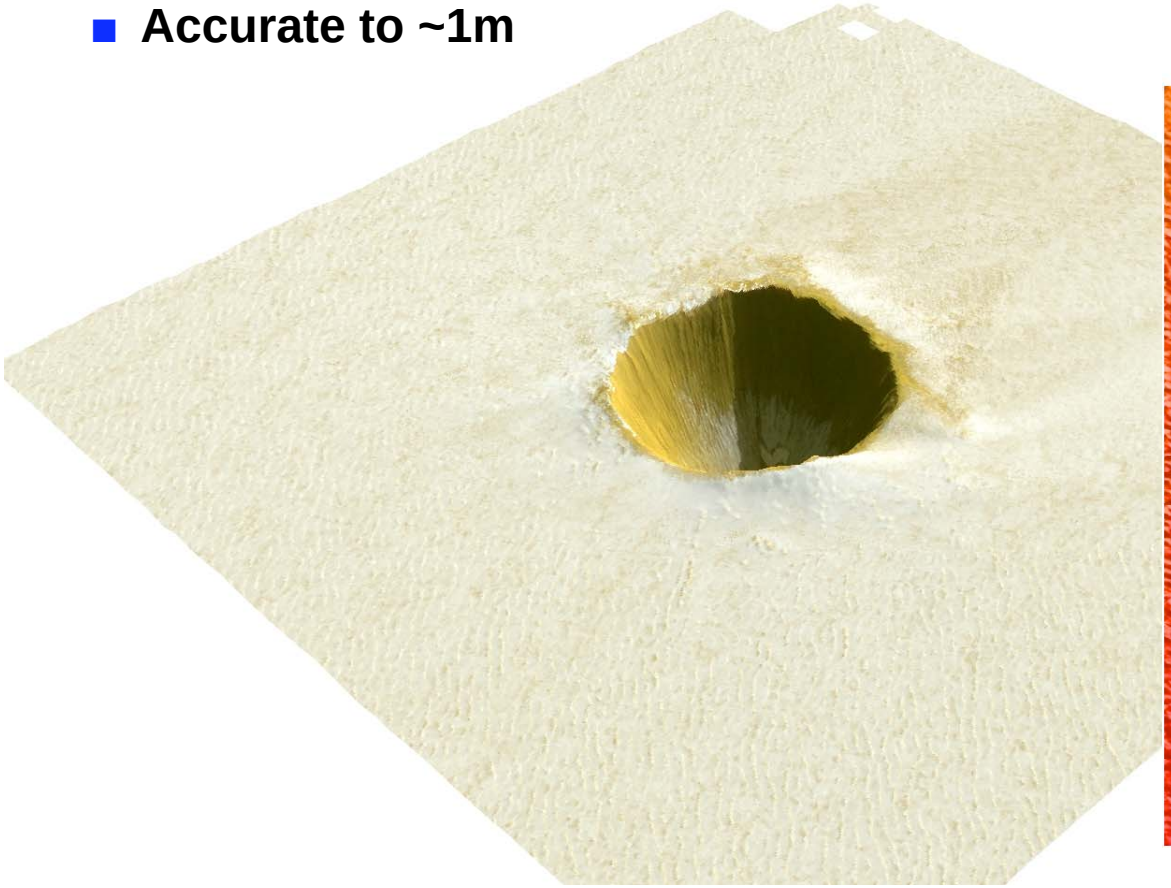


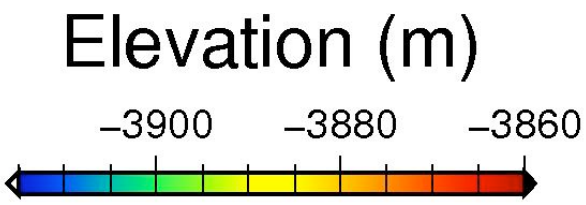
- Focus on one crater ~200m in diameter
  - Excavated to 40m – pretty deep…
  - Change in material with depth?
    - Albedo boundary on wall

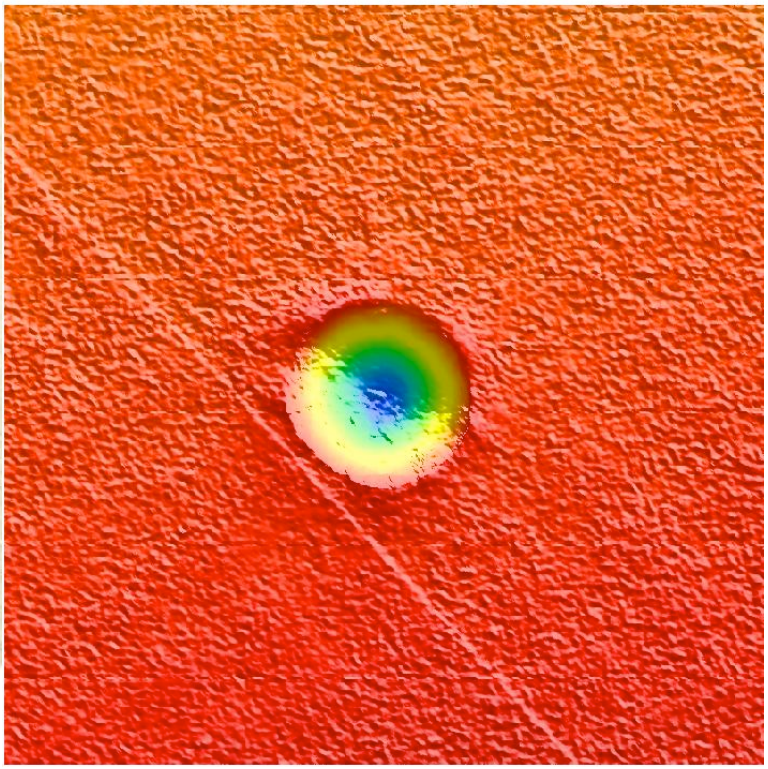


- Ice in bottom
  - Newly formed?

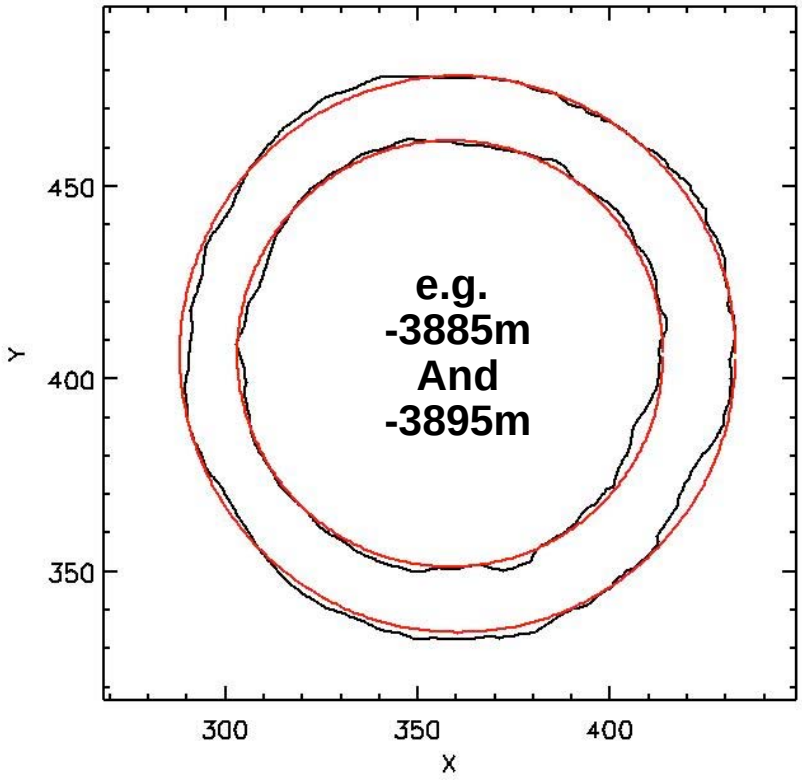
- **Stereo DEM available**
  - **Still being refined**
  - **1m posting**
  - **Accurate to ~1m**



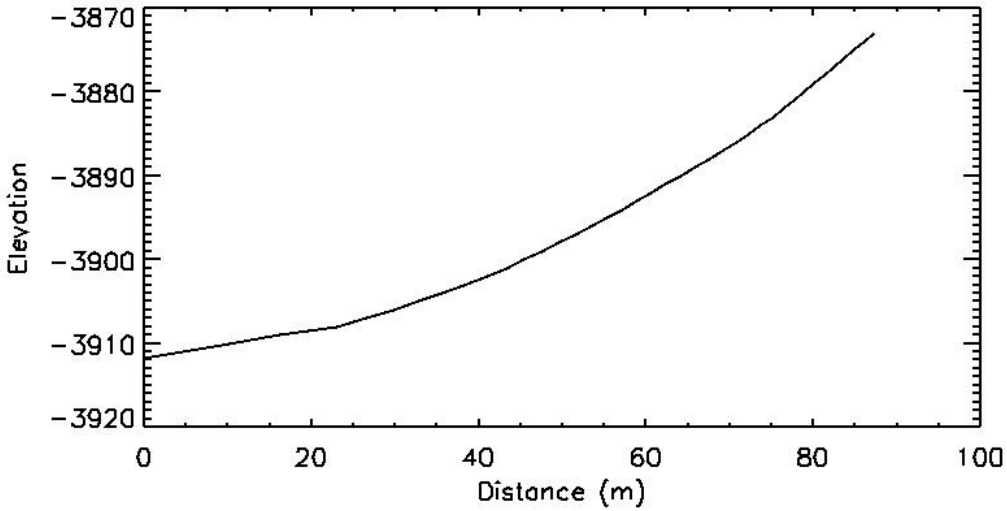




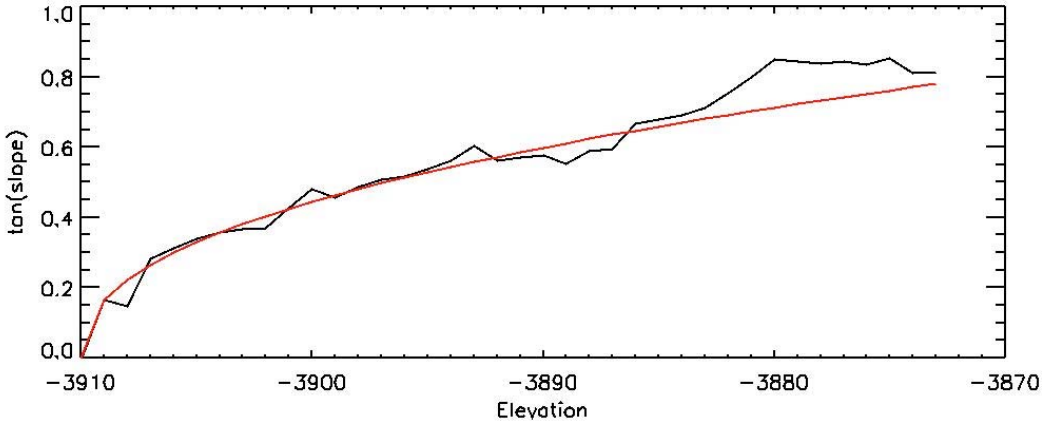
- **Horizontal slices shows how the crater changes shape with elevation**
  - **Done every vertical meter**
  - **Fit a circle to the intersection of the DEM and slice**



- **Crater shape looks pretty typical**
  - **Slopes increase with radius**



- **A closer look**
  - **Take Garvin's crater shapes**
    - **Fit to craters KMs in size**
  - **Slope proportional to $z^{0.43}$**
  - **Change in crater shape**



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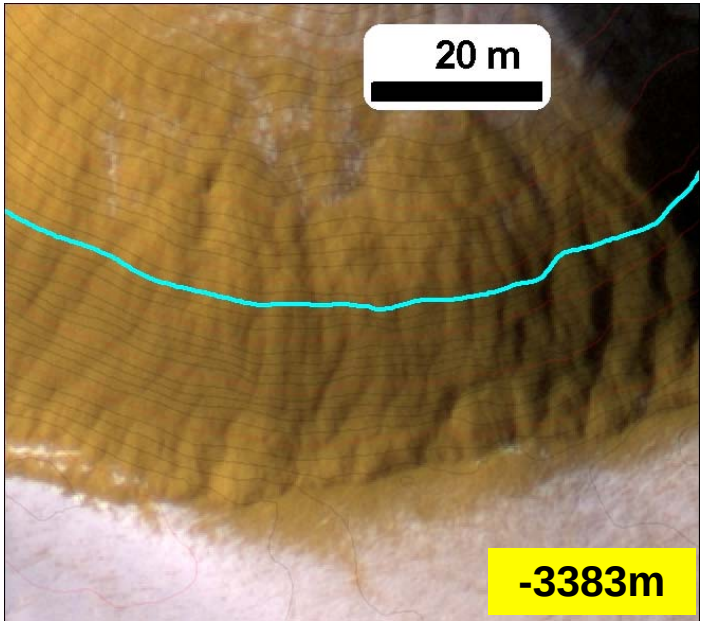
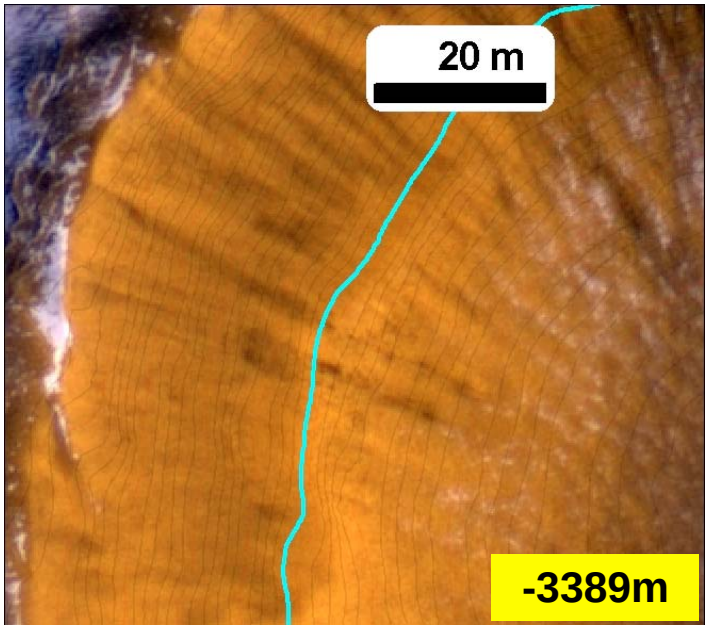
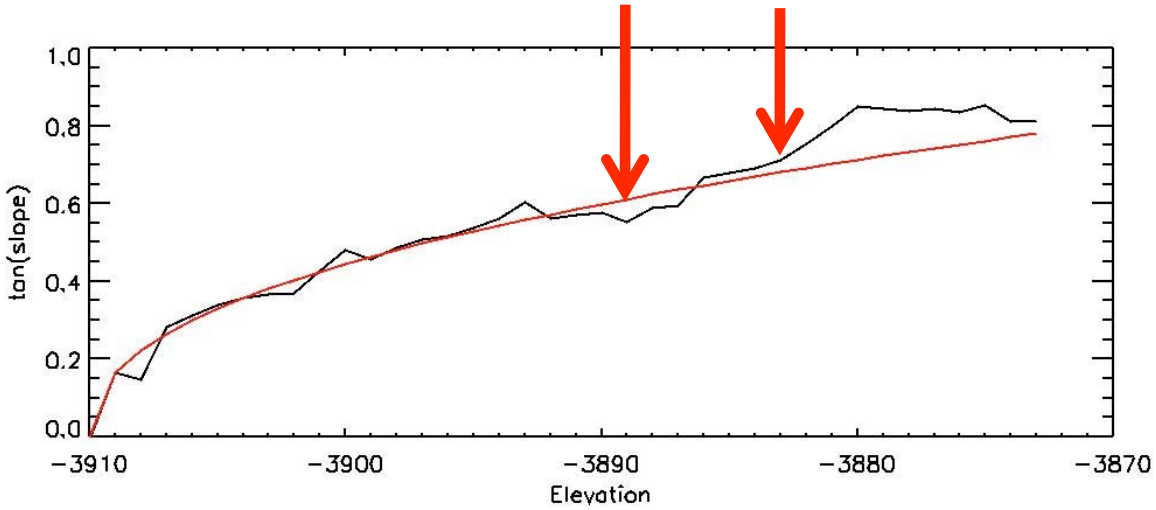
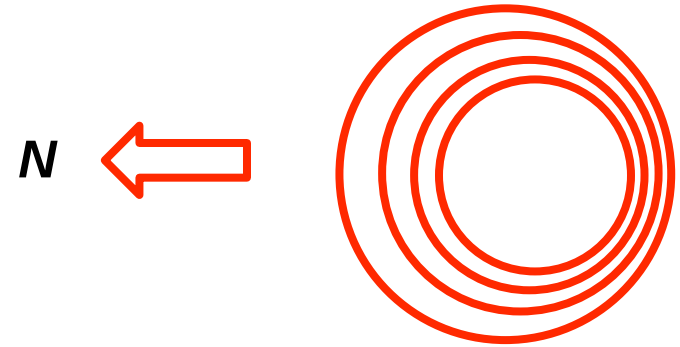






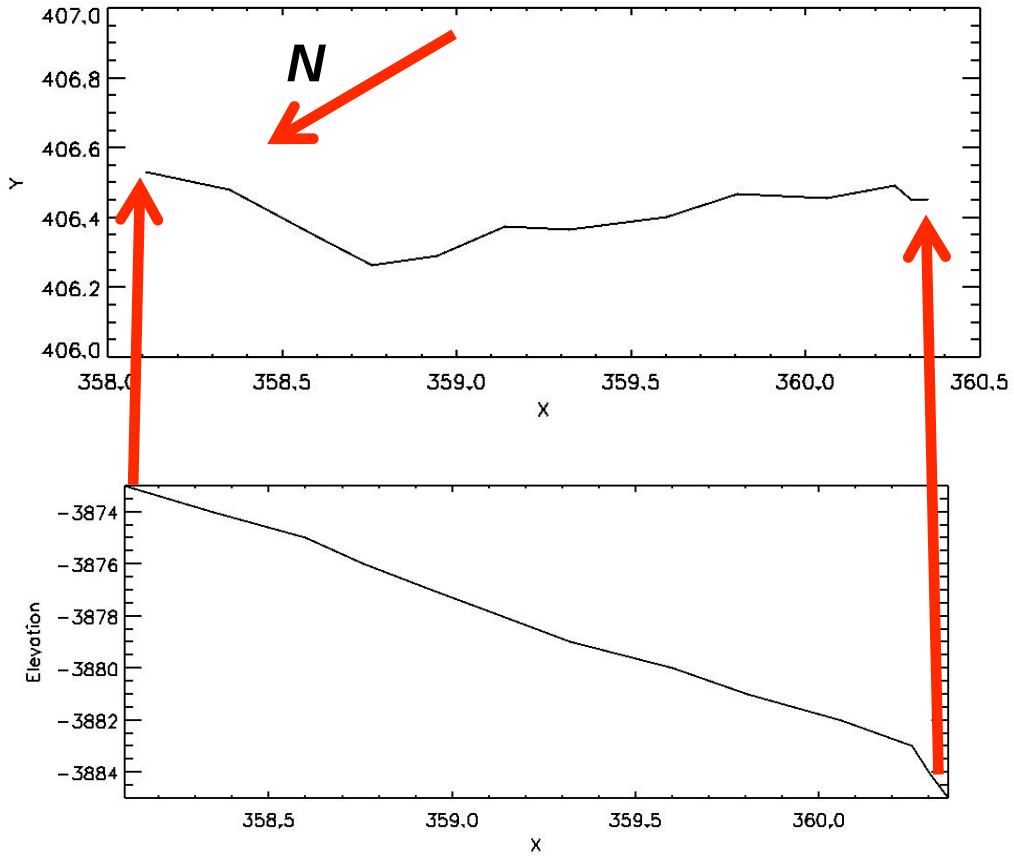
- **Crater shape changes coincide with albedo changes**
  - **Change in the material 25±3 m deep?**

- **Evidence for ablation?**
  - **Slopes higher at higher elevations**
  - **More ablation higher up**
  - **More ablation on equatorward facing side**



Crater expands asymmetrically

Center of crater moves northward

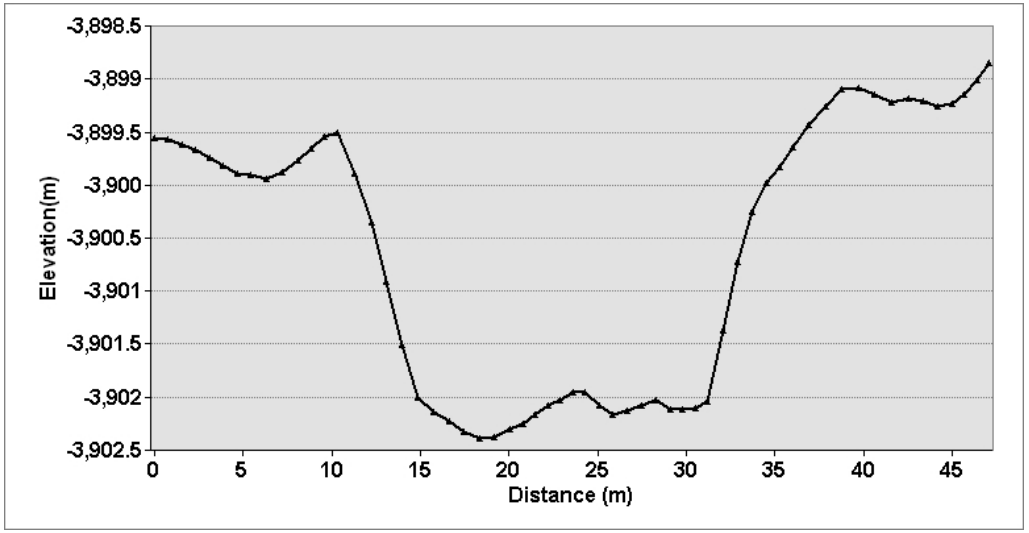


Crater walls are ablating outwards

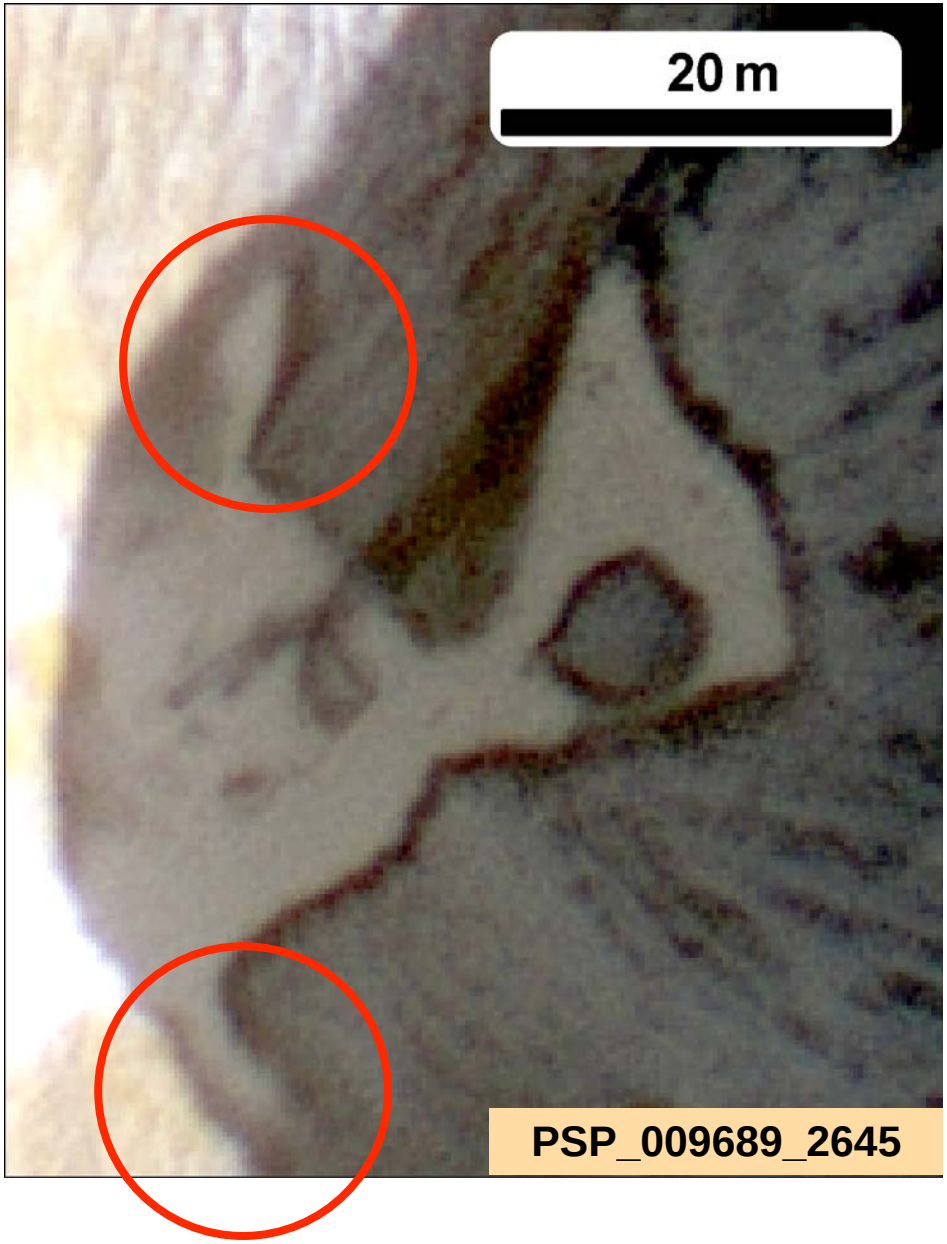
South-facing walls by at least 5m more than North-facing walls

- **Stereo topography shows ice patch is a low (opposite of what I thought)**
  - **Original crater floor not covered up yet**

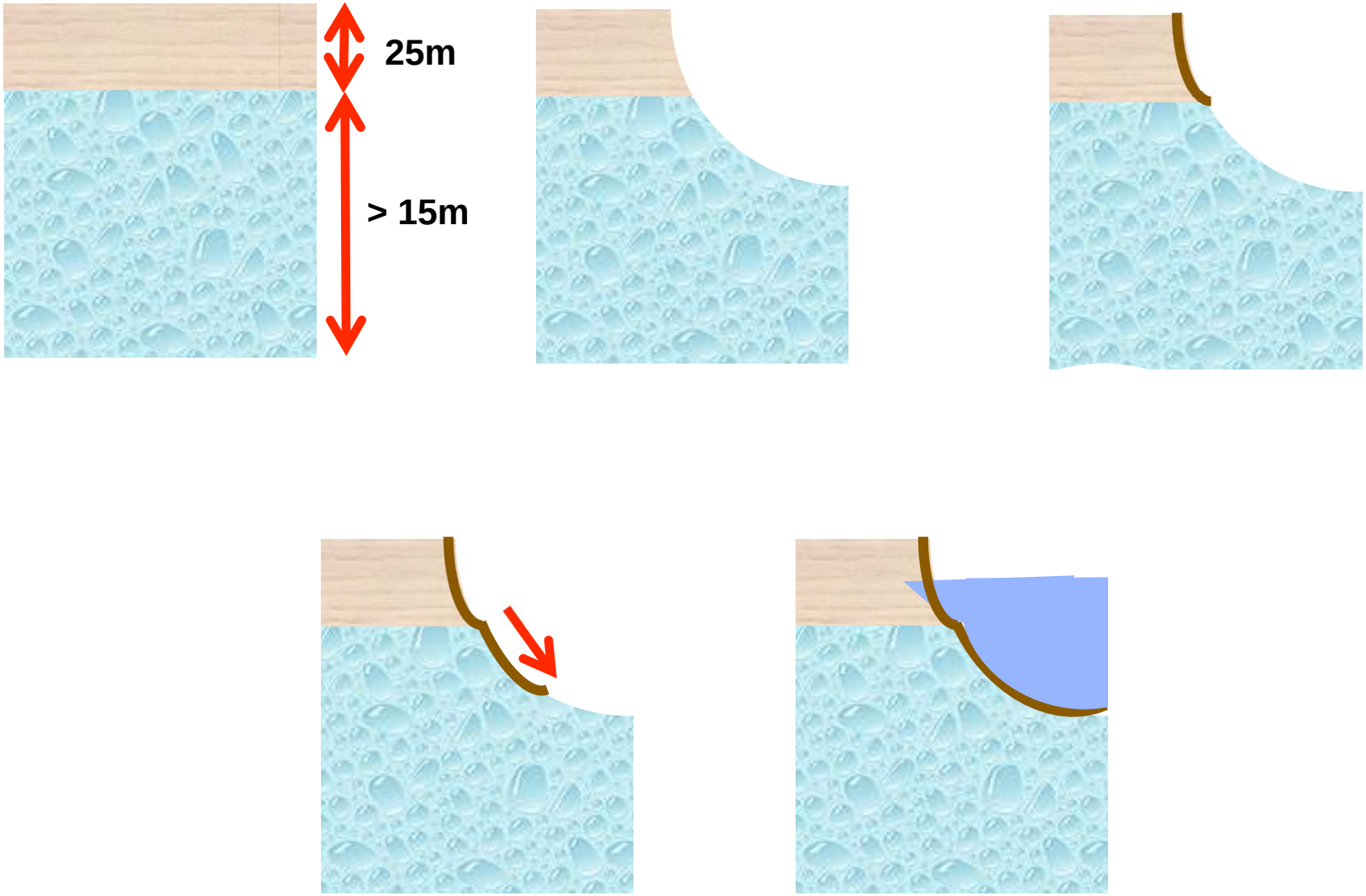
Lots of work by Sarah Mattson



- **Changes in 400 orbits?**
  - **Orthorectified versions in preparation**

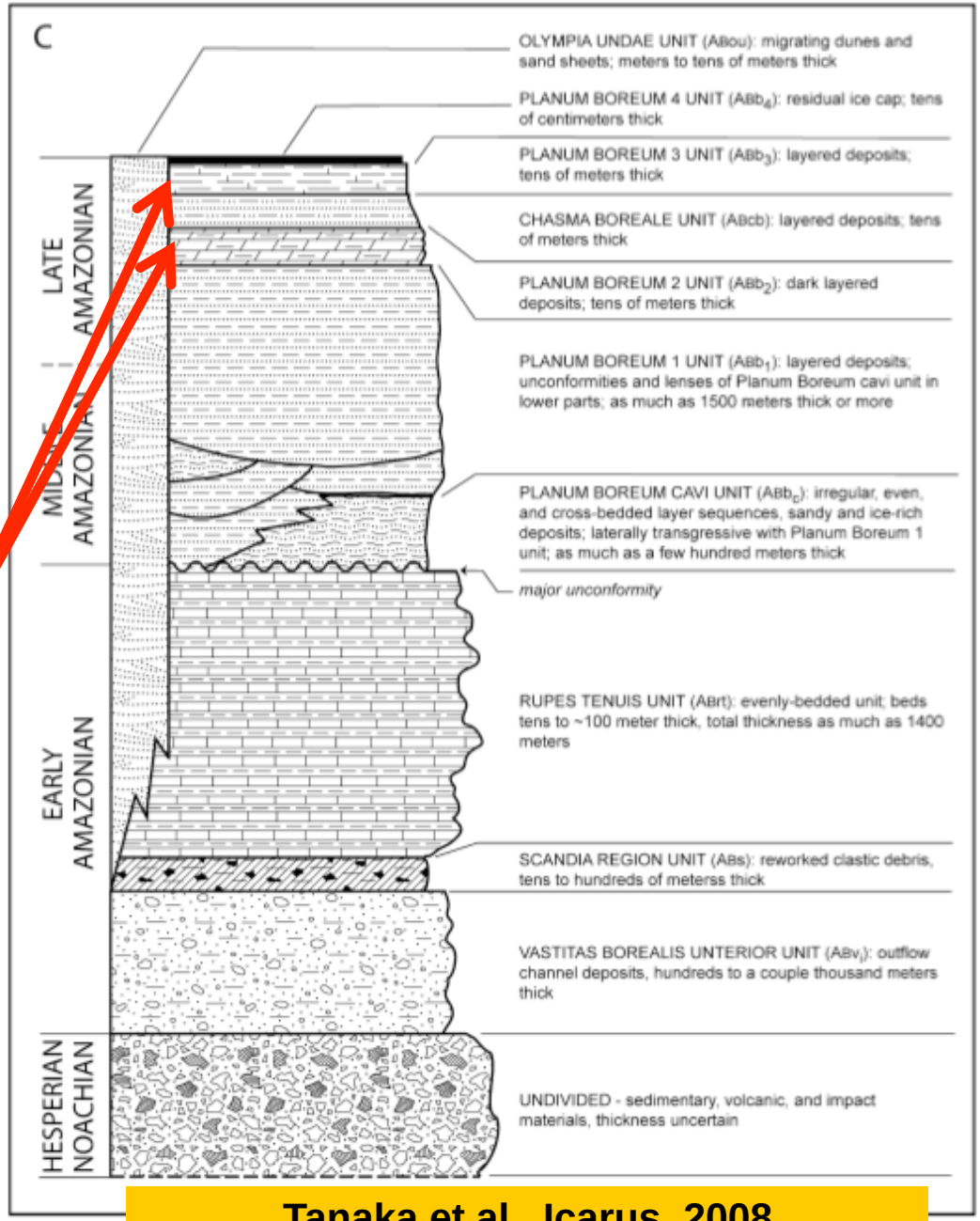


- **Conceptual model**
  - **A dirty ice layer over cleaner stuff**



- **NRC is an equilibrium surface**
  - **At least for the last 10 Kyr**
  - **Crater lifetime α $D^{0.85-1}$**
  - **Resurfacing rate will need to be backed out of the crater removal rate with models**

- **Large (200m) crater sample below a ~25m thick dirty ice layer**
  - **Banded terrain?**
  - **Intermediate deposits?**



Tanaka et al., Icarus, 2008

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