Craters and Resurfacing of the Martian North Polar Cap

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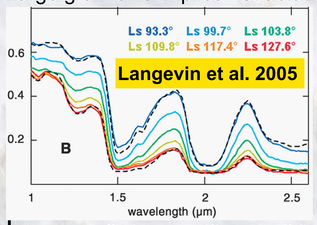
30 Second Summary...

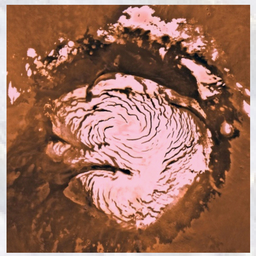
- Mass Balance of the north polar cap is uncertain.
- We need to connect current behavior to current climate to infer past climate from the polar layered deposits.
- Searched for craters in the CTX dataset to constrain resurfacing timescales, ~70 craters found.
- Followed up with HiRISE on ~40 of these.
- Craters are sites of preferential ice accumulation.
- Ablation and eolian erosion contribute to crater removal.
- Population statistics consistent with an equilibrium population with crater lifetime proportional to $D^{0.88}$

North polar residual cap

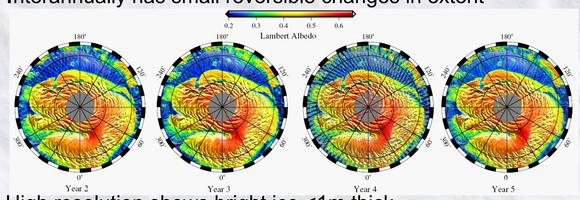
Water-ice, large grained, dust-free

Large grain size implies net ablation





Interannually has small reversible changes in extent

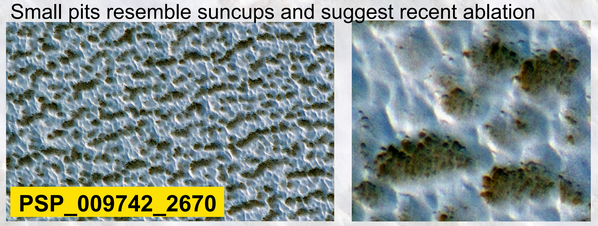


High resolution shows bright ice <1m thick

Over darker (i.e. larger-grained+older) ice

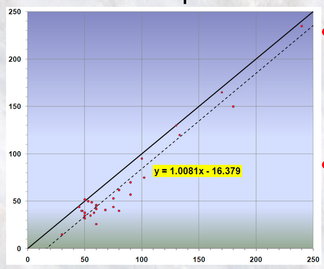
Linear arrangement of patches suggests eolian organization

Small pits resemble suncups and suggest recent ablation

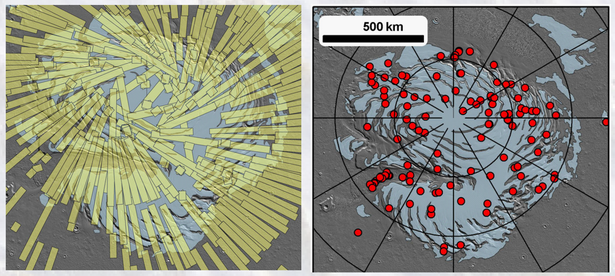


CTX crater search

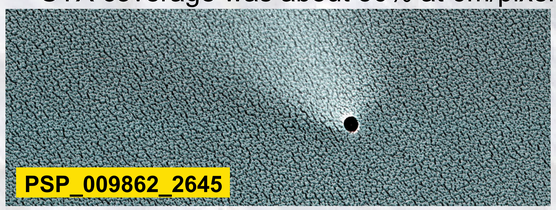
- PDS products projected in ISIS and searched using ArcMAP
- >100 craters found on the residual cap and NPLD combined (only 4 previously known)
- 70 craters on residual cap observed with CTX
- 37 followed up with HiRISE (several in stereo)



- Craters easy to see in CTX due to wind streaks
- HiRISE comparison shows that our CTX measurements overestimate diameters.

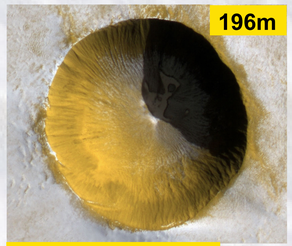


- CTX coverage was about 50% at 6m/pixel

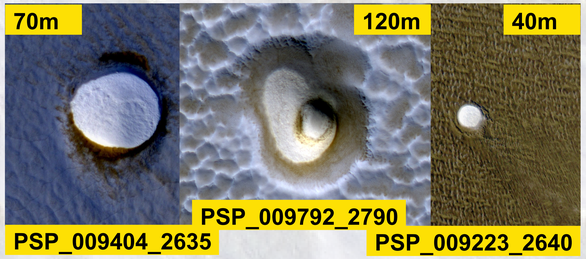


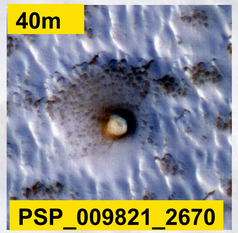
Crater Removal

- Some craters are VERY fresh d/D ~ 0.25

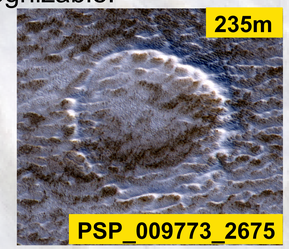


- Most craters are being infilled
- Accumulation here in preference to surroundings
- Shadowing kickstarts accumulation
- Starts positive feedback, fresh ice (small-grained) is bright - stays cooler.





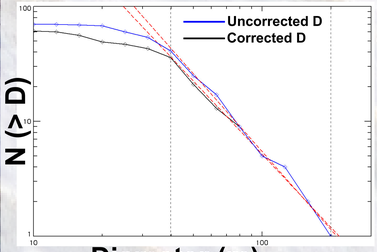
- Ablation pits (sun cups) are common and degrade the rims.
- Eolian action also erodes the rims.
- Some craters are barely recognizable.



Full range of morphologies allows "space-for-time" substitution

Population Statistics

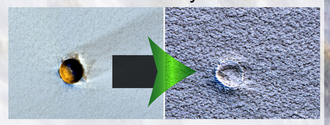
- Size-frequency plots can either give:
  - An age for a 'production surface'
  - A resurfacing rate for an 'equilibrium surface'
- Surface is very young so all these craters are probably primary impacts



- We can correct the CTX-only diameters.
- Slopes of -2.1 or -2.2 for uncorrected or corrected diameters.
- Production function (from Hartmann) expected to have slopes of -3 here (Primaries + Secondaries).
- So either:
  - Primary production has a lower size-freq slope than primary+secondary production.
  - This is an equilibrium population and many craters have been erased.
- We favor the latter based on the range of morphologies
- **An equilibrium surface with crater lifetime proportional to $D^{0.8}$ to $D^{0.9}$.**

Modeling Polar Cap Resurfacing

- Resurfacing of cap not directly tied to crater removal rate as craters are preferred sites for new deposition.
- We're starting landscape evolution modeling of accumulation, ablation and eolian redistribution of ice to modify craters.
- Craters make perfect control features and constrain rates of processes.
- Current population accumulated in ~10^4 years.



Montmessin et al. 2007