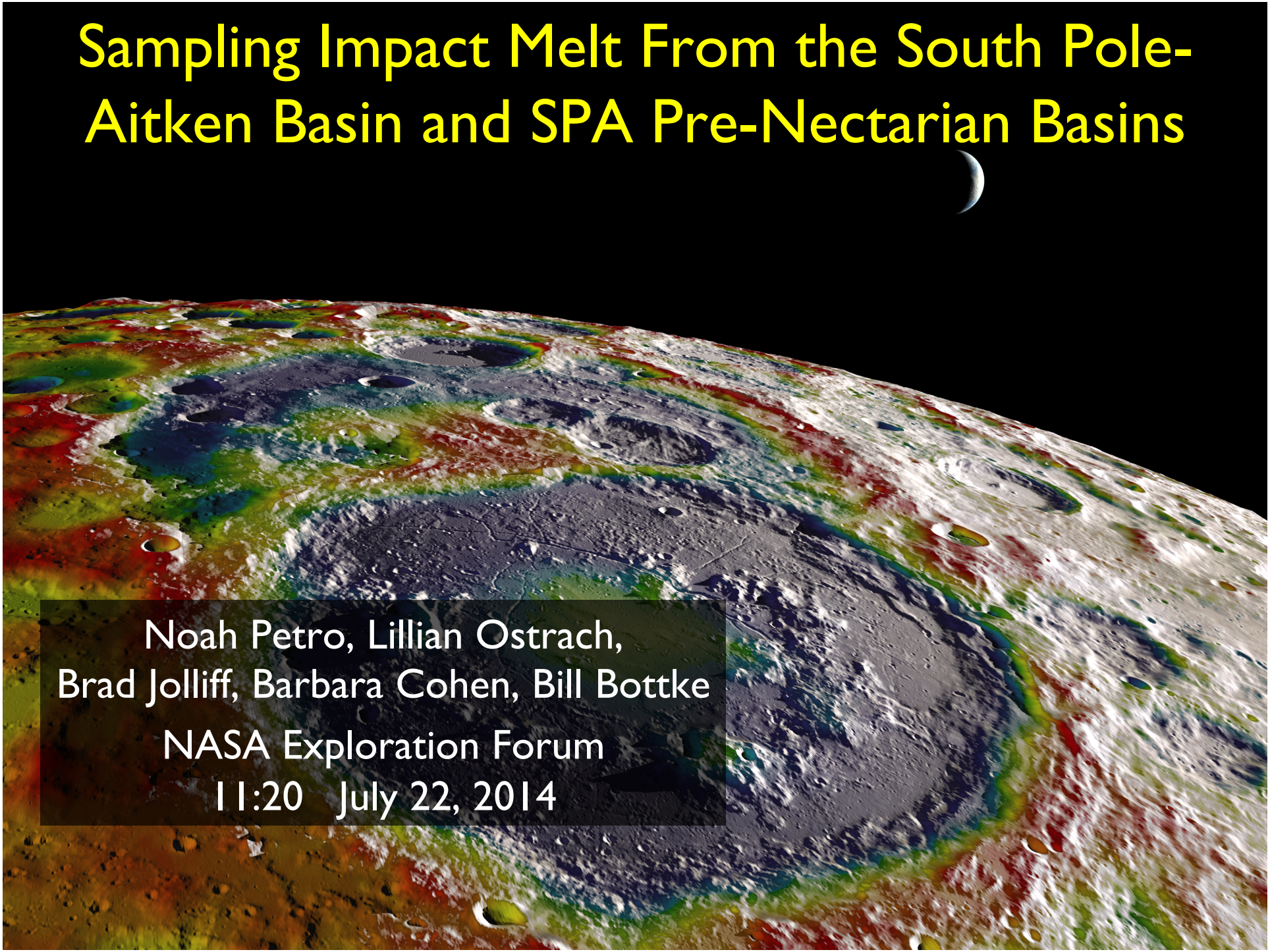
Sampling Impact Melt From the South Pole-Aitken Basin and SPA Pre-Nectarian Basins



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Brad Jolliff, Barbara Cohen, Bill Bottke

NASA Exploration Forum
11:20 July 22, 2014

Moon-Forming Impact Ejecta as the Source of the Earliest Lunar Bombardment by B. Bottke

- Presentation yesterday:
  - Giant Impact ejecta impacting the Moon may explain Pre-Nectarian basins
    - Oldest cratered terrain on Moon ~8 My after GI
      - ~25 basins, and SPA/Procellarum
    - Big impacts < 8 My may make basin-like palimpsests
- What are the prospects of sampling post-SPA, Pre-Nectarian basin material in SPA?

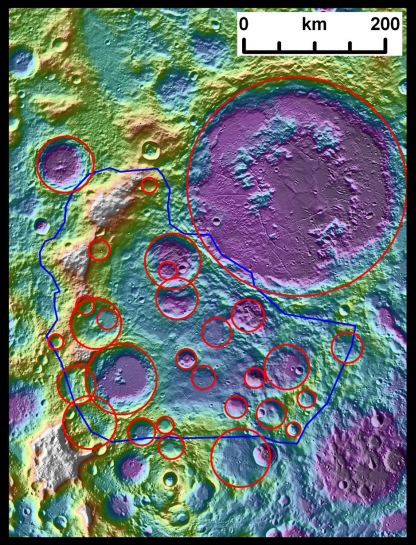
Previous Thoughts on SPA Regolith

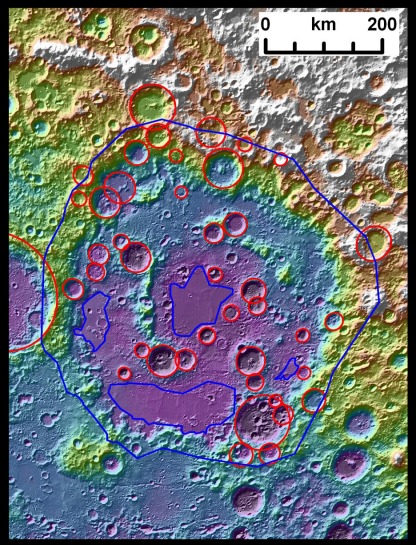
- Haskin et al. (2003) and Petro and Pieters (2004) modeled the regolith provenance for central SPA → ancient SPA floor material dominates the regolith
- SPA interior accumulates relatively small amount of basin ejecta (Petro and Pieters, 2008)
- At past NLSI forums we've examined the effects of smaller craters on the SPA regolith (Cohen and Coker model) → small craters contribute their own small volume of impact melt, but mainly rework SPA melt

pNc Basins within (or near) SPA

(Fassett et al, 2012)

Name	N(20)	Notes
Australe	>180	Exterior to SPA
Amundsen-Ganswindt	202 ± 37	Straddles SPA rim
Poincaré	194 ± 44	Thin crust
Ingenii	167 ± 67	Near Th anomaly
Apollo	151 ± 23	Thin crust

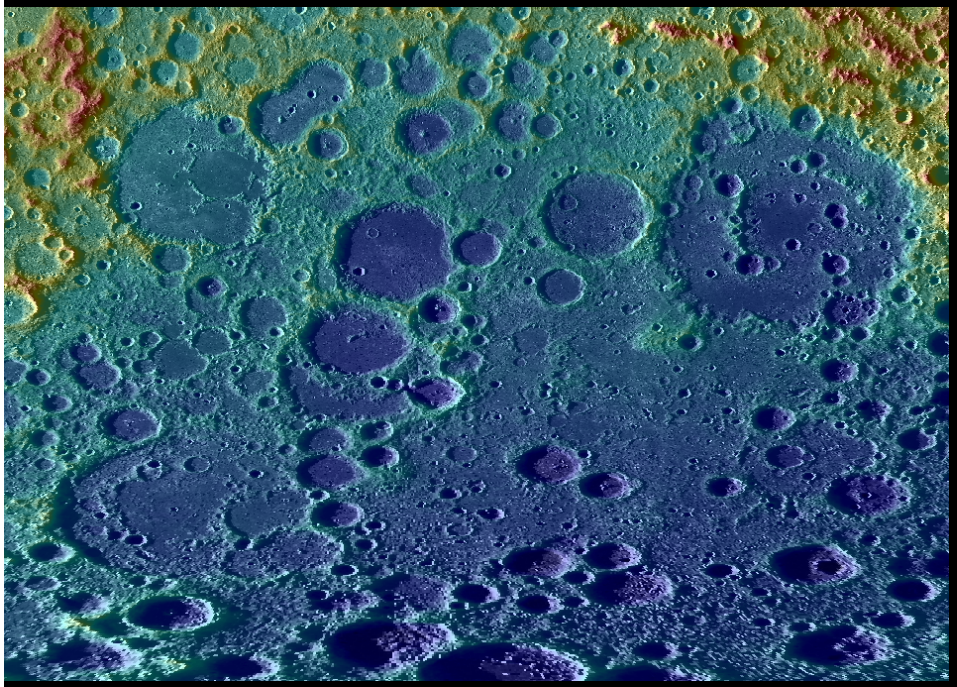




- Certainly others may be present…
- How much melt is distributed by these events?
- How much of their ejecta/melt is in the regolith today?
- How does it vary across SPA?

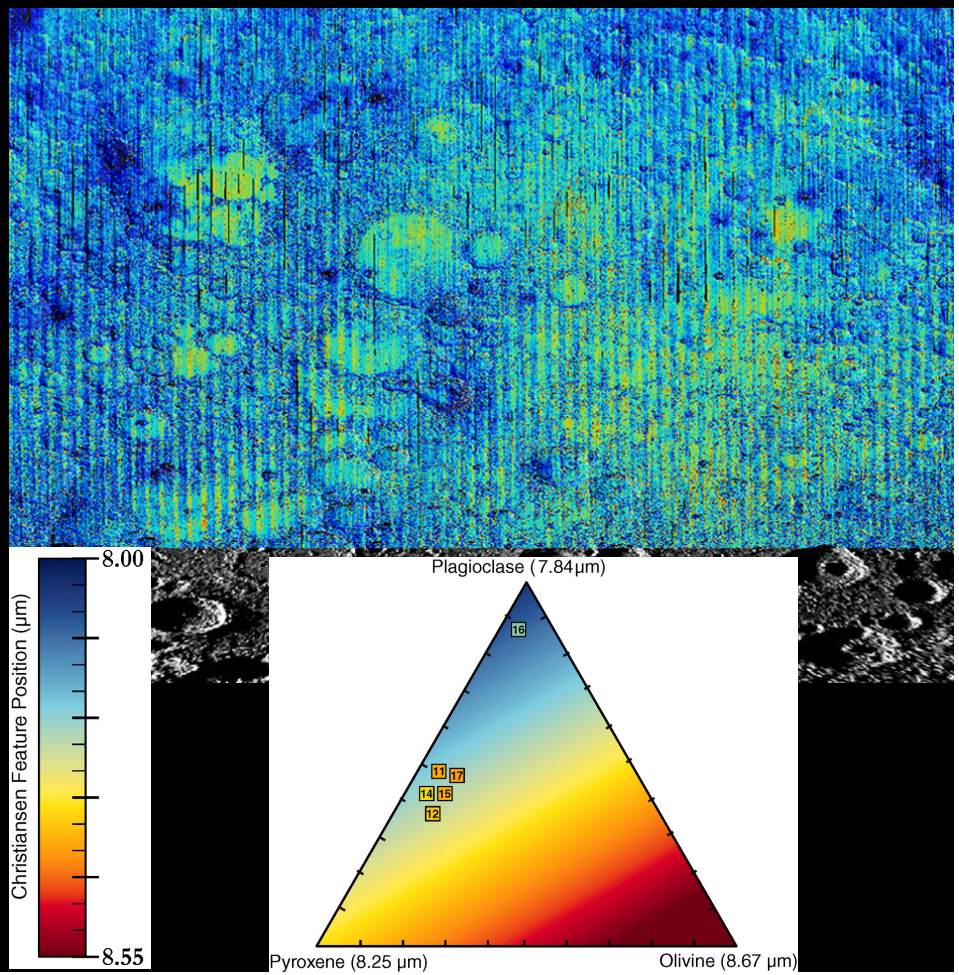
SPA

Topography



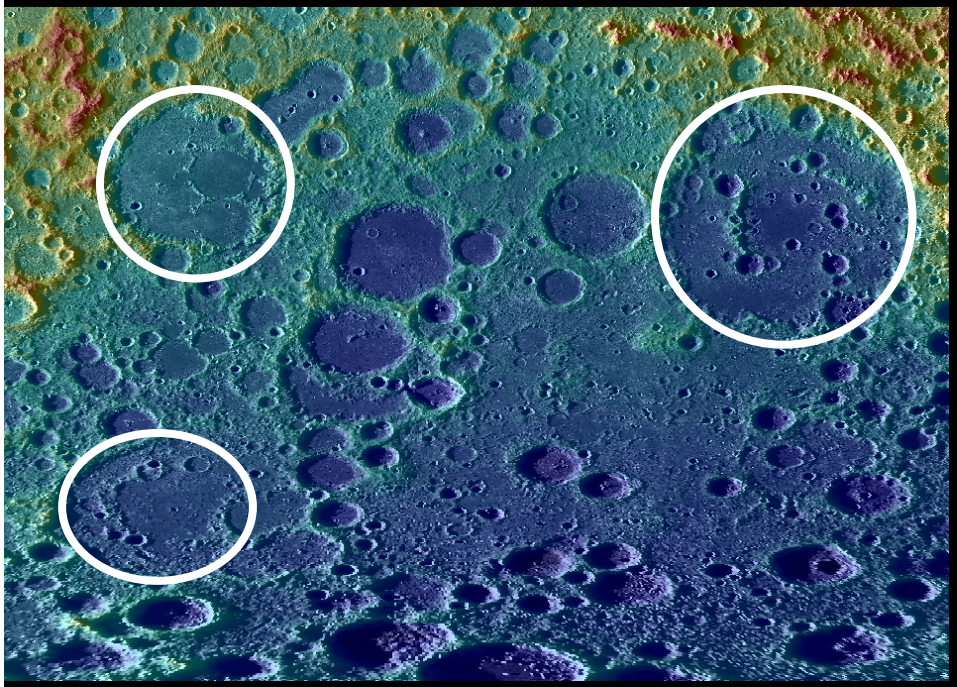
-9km 8.5km

Composition (CF)



SPA

Topography



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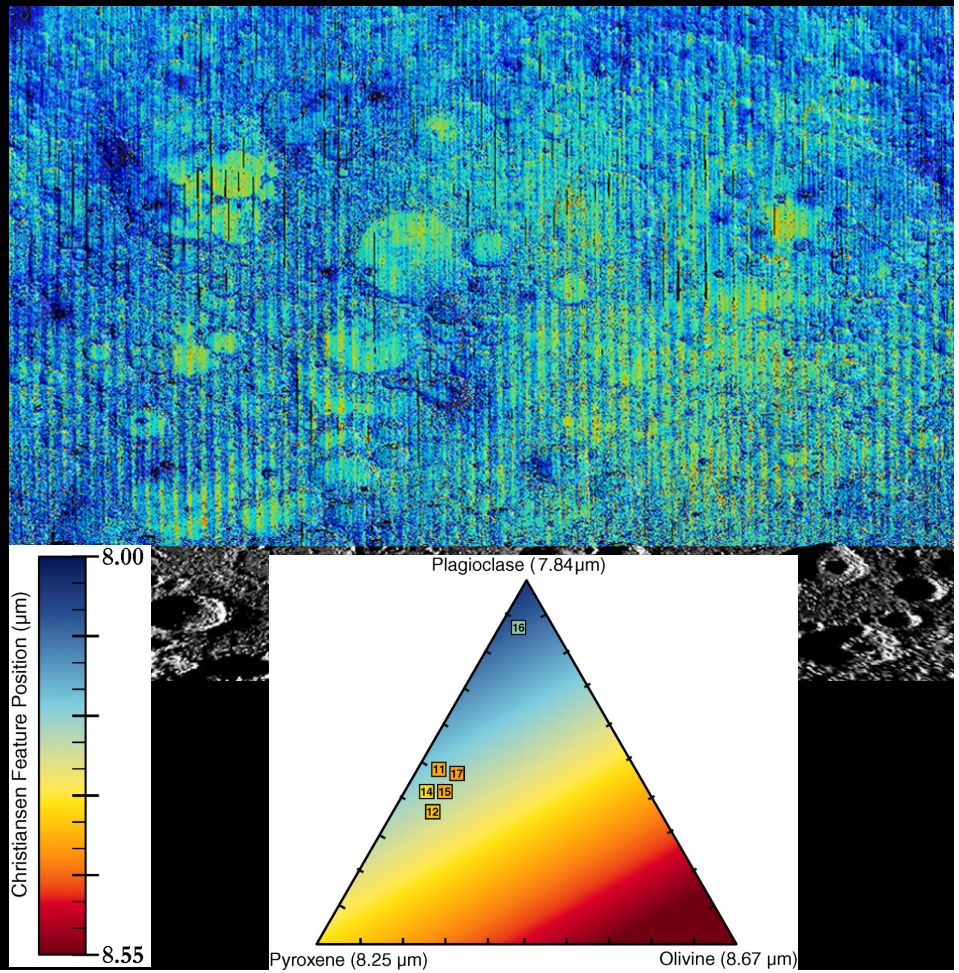


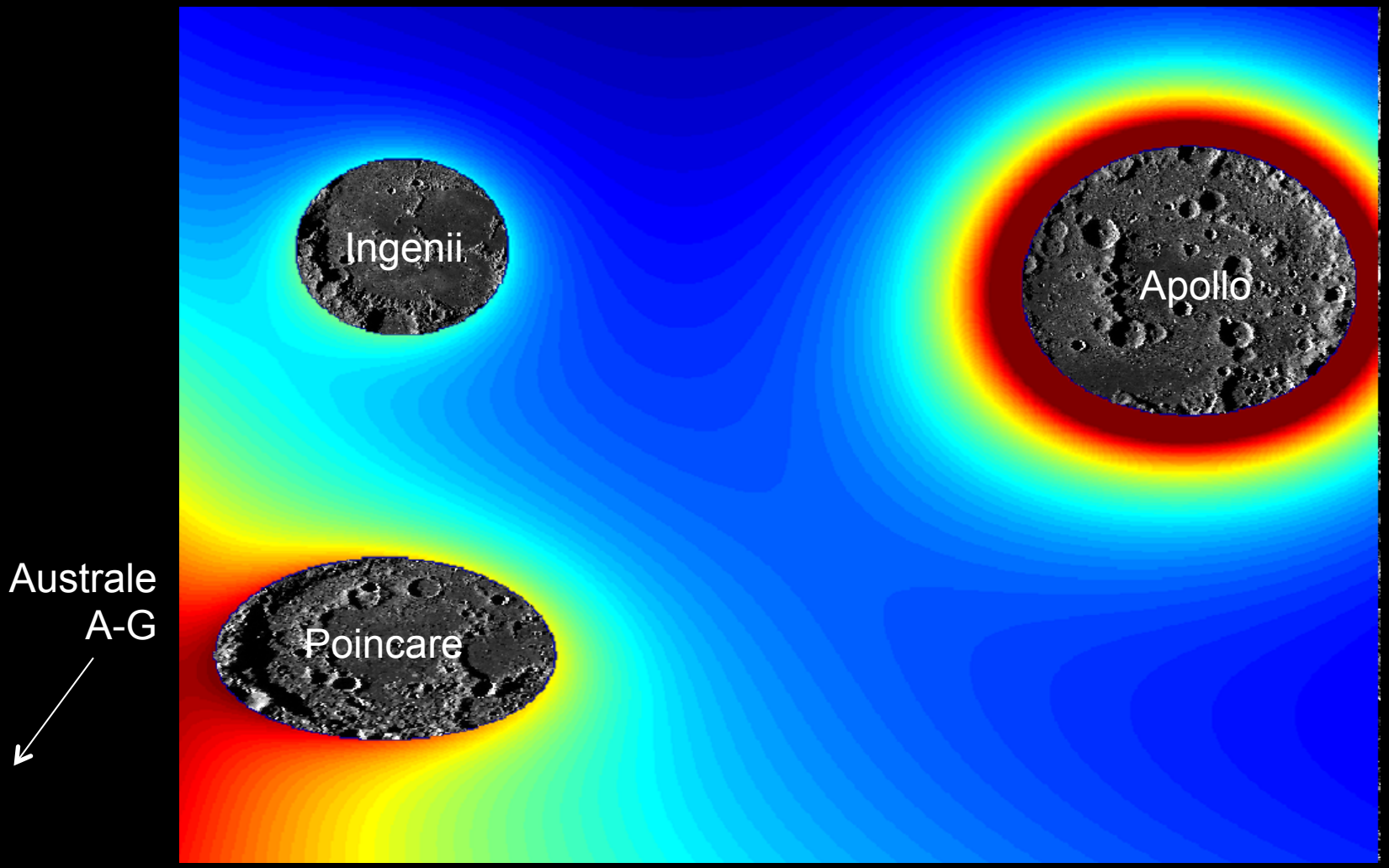
Fraction of melt in pNc Basin

Name	F_{melt} (%)	Notes
Australe	8	Exterior to SPA
Amundsen-Ganswindt	5	On SPA rim
Poincaré	5	Thin crust
Ingenii	4	Near Th anomaly
Apollo	6	Thin crust
Imbrium	9	Is Imbrium

- F_{melt} is the percent of melt in a crater's ejecta deposit (Volume of melt x fraction of melt ejected; Cohen and Coker, 2010)
- What is the distribution of ejecta from these basins?

Ejecta Distribution – pNc basins

Based on Fassett et al., 2011 ejecta scaling model



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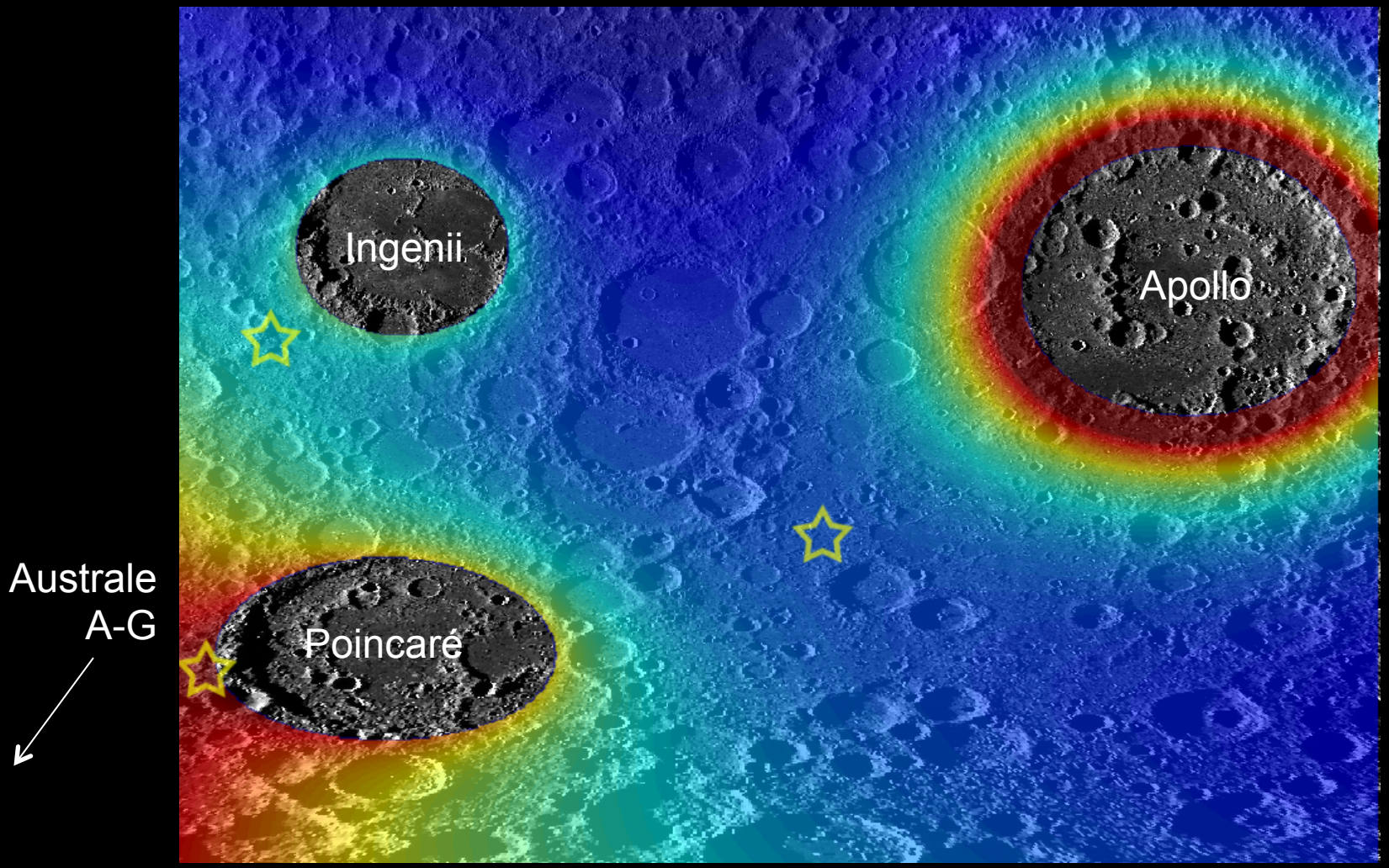
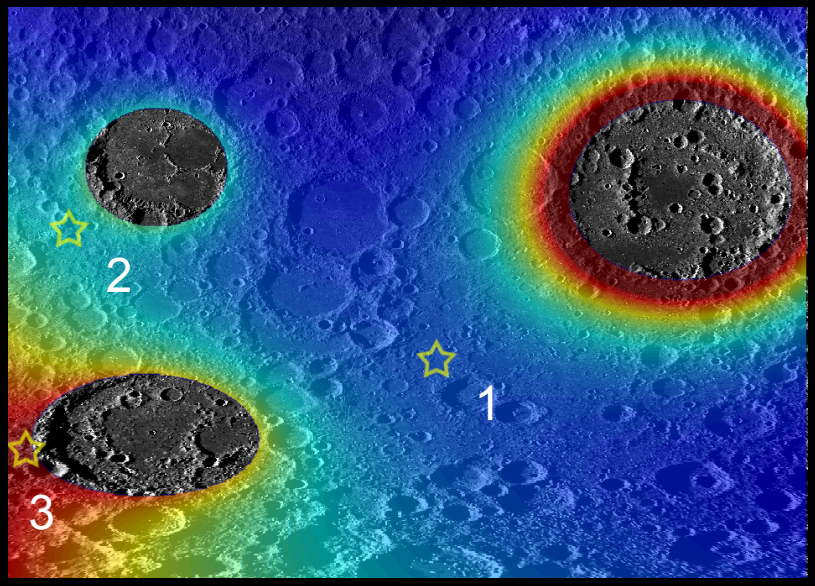


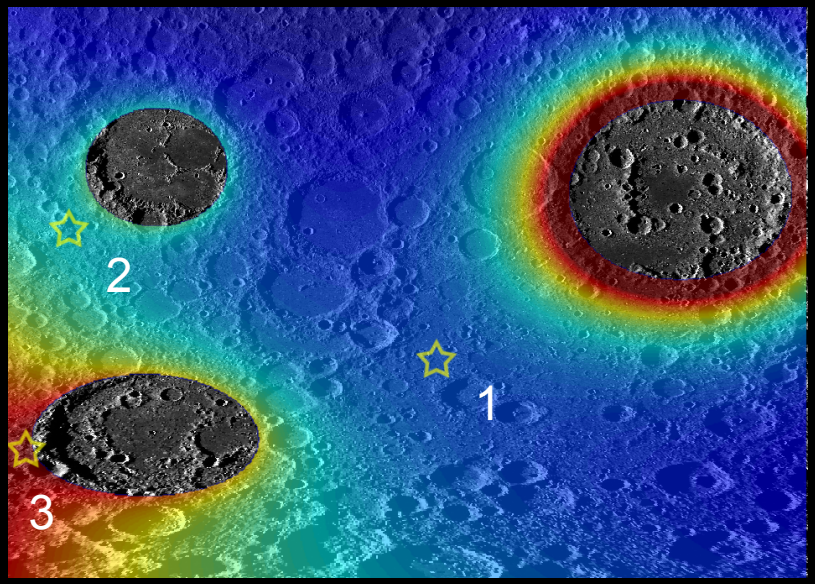
pNc Basin Melt

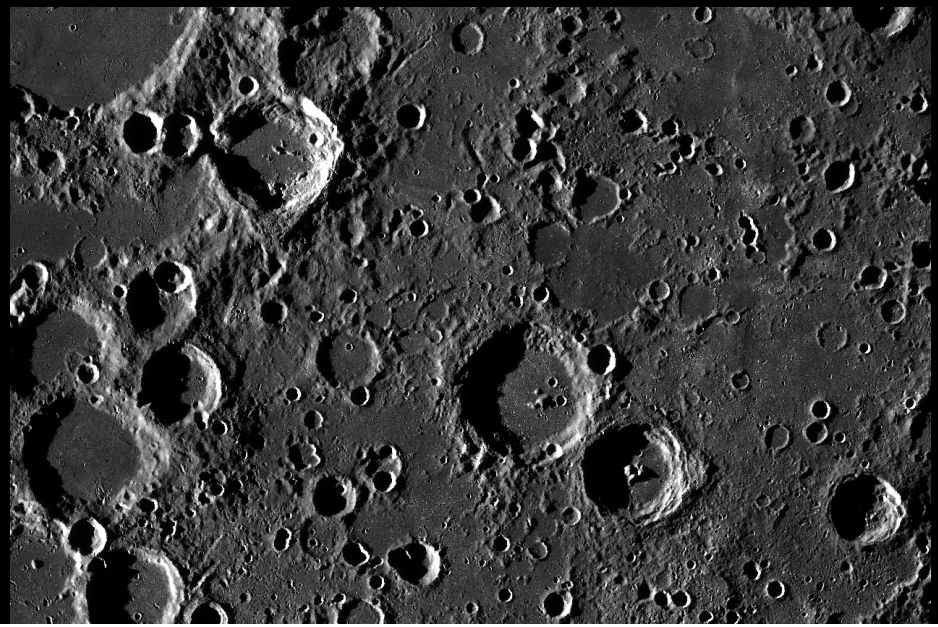
- Australe is the primary contributor across the basin
- Others are strongly site dependent
- Would any contribution (ejecta) from these basins survive subsequent dilution by other basin ejecta? (Petro and Pieters, 2004, 2006)
- If so in what proportion?



Site 1 – Northwest of Bose

Name	F_{melt} (%)	F_{ejecta} (%) t=0	F_{ejecta} (%) t=now
Australe	8	12	7
Amundsen-Ganswindt	5	15	<1
Poincaré	5	22	<1
Ingenii	4	18	<1
Apollo	6	20	3
Imbrium	9		5
Orientale	8		11
Schrödinger	4		1
Bose (age?)	2		25





- Nearby craters (Bose, Alder) contribute ejecta (mainly SPA floor and basement material)

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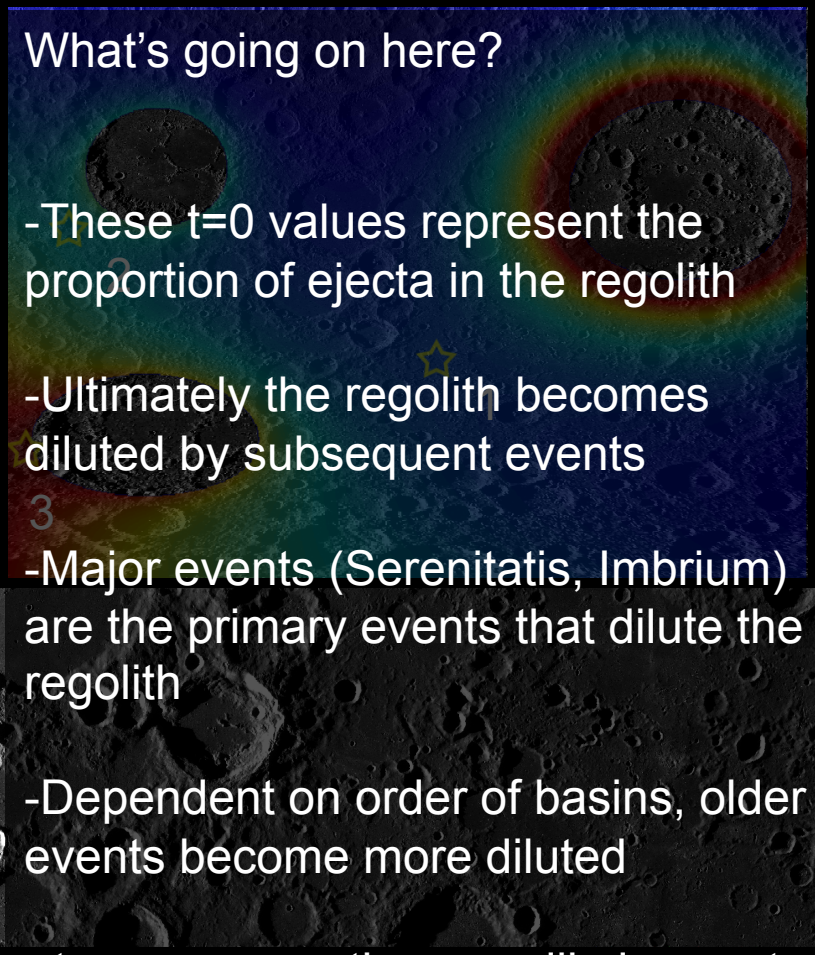
Orientale	8		11
Schrödinger	4		1
Bose	2		~15

- Nearby craters (Bose, Alder) contribute ejecta (mainly SPA floor and basement material)

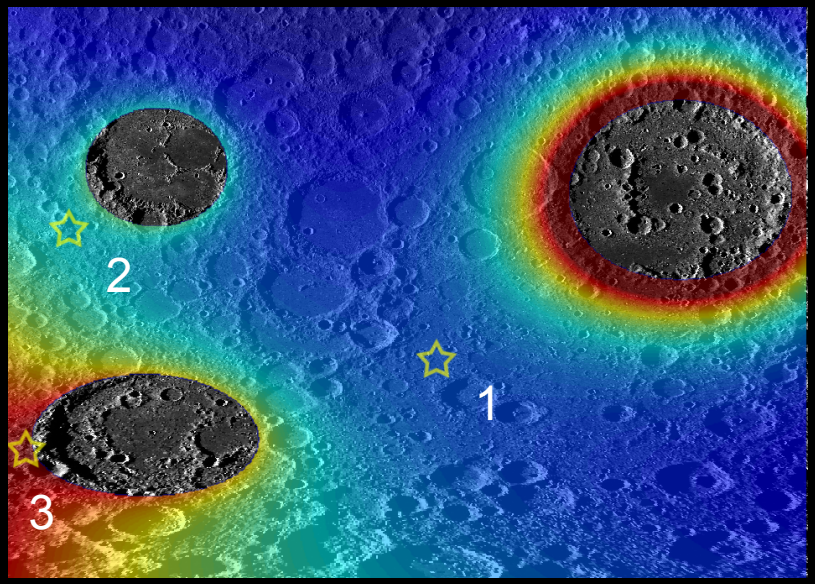


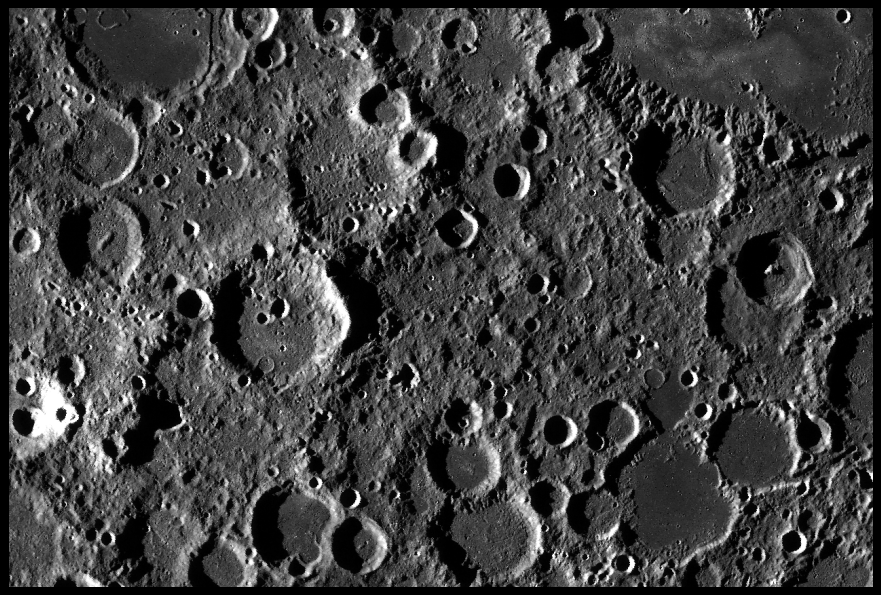
- t=now proportions are likely worst-case scenarios for these sites (assume lunar-wide distribution, uniform mixing)

Site 2 – Southwest of Ingenii

Name	F_{melt} (%)	F_{ejecta} (%) t=0	F_{ejecta} (%) t=now
Australe	8	14	6
Amundsen-Ganswindt	5	14	<1
Poincaré	5	22	<1
Ingenii	4	26	1
Apollo	6	14	<1
Imbrium	9		6
Orientale	8		9
Schrödinger	4		1

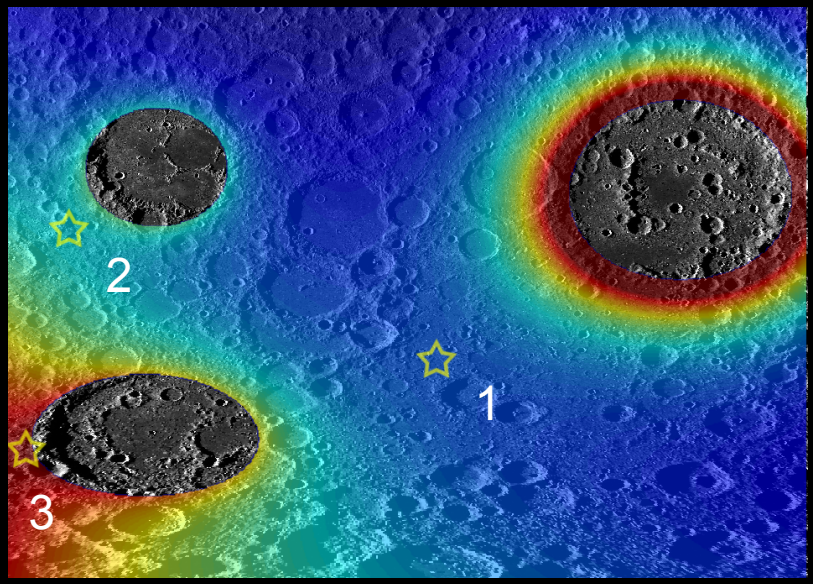
- Modest accumulations from pNc basins
- Close to Imbrium antipode

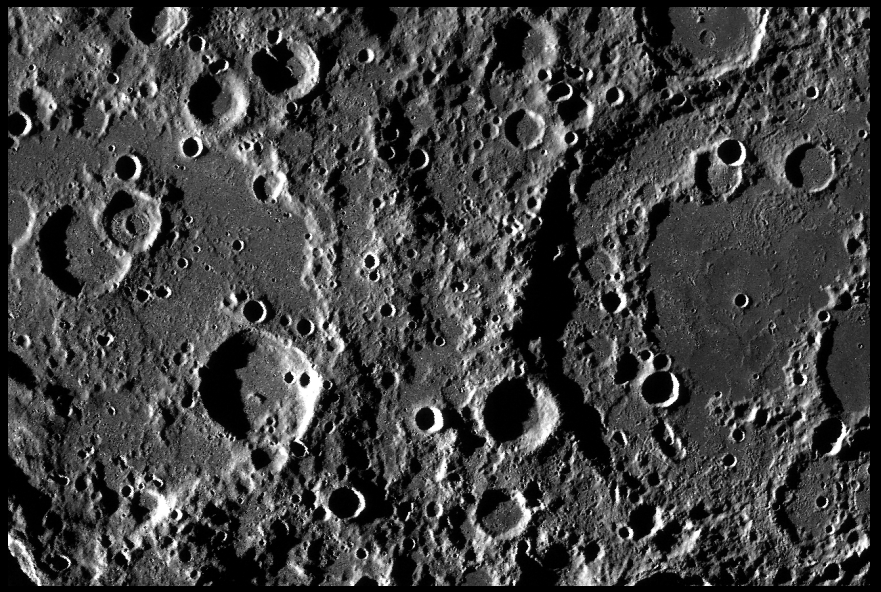




Site 3 – Southwest of Poincaré

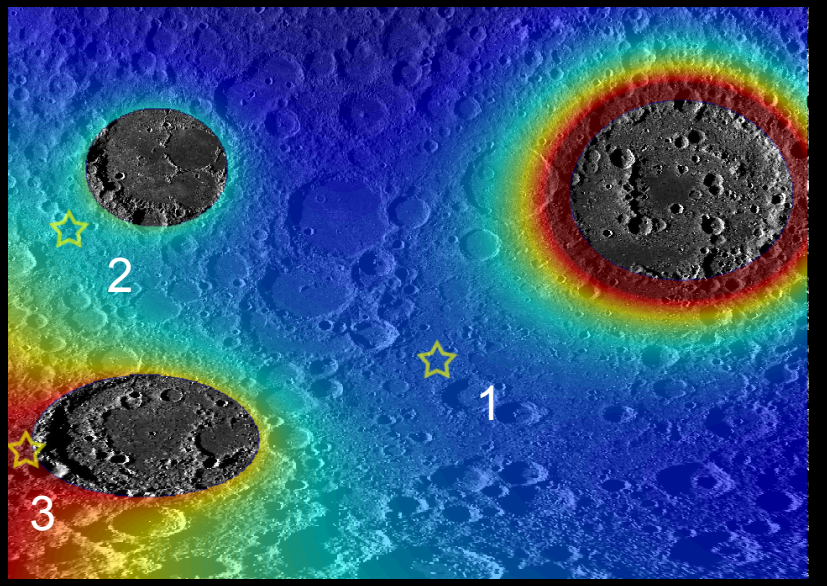
Name	F_{melt} (%)	F_{ejecta} (%) t=0	F_{ejecta}(%) t=now
Australe	8	16	16
Amundsen-Ganswindt	5	18	<1
Poincaré	5	30	6
Ingenii	4	18	<1
Apollo	6	14	<1
Imbrium	9		6
Orientale	8		9
Schrödinger	4		4





- Australe dominates regolith

Conclusions



- Contributions from pNc basins are modest and are diluted by subsequent cratering events
- Regolith samples from any of the 3 sites are dominated by SPA "basement" and could contain pNc basin material; SPA + pNc basins > 78% of regolith
- Samples from SPA can:
  - Test the age of the GI event (is SPA impactor ejecta from GI event?) and possible cluster of impacts ~8 My (see Bottke talk yesterday)
  - Provide indications of the composition of the impactor (Wieczorek hypothesis)
  - And more…

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“Apollo 16 Zone”