Pulling marbles from a bag: Deducing the regional impact history of the SPA basin from impact-melt rocks

Barbara Cohen and Robert Coker
NASA Marshall Space Flight Center
Huntsville AL 35806
(Barbara.A.Cohen@nasa.gov)

SPA floor rocks

- After formation, SPA surface materials became a mixture
  - Original SPA floor rocks
  - Reworked SPA material from interior basins
  - Exogeneous material

- Different starting point from Apollo sites - SPA floor is the substrate; remote sensing sees unique geochemical signature
- Ejecta and mixing models (Haskin et al. 2003, Petro & Pieters 2004) show ~20% of SPA regolith is foreign – but much of foreign material will be cold ejecta, not impact melt rocks

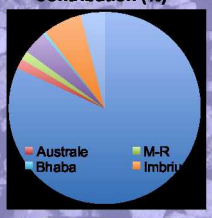
Impact-melt rock origin

- Fraction of material that is likely to be non-SPA impact melt using scaling laws

$F_{melt} = (V_{melt} / V_{ejecta}) \times E$

Volume of impact melt (Cintala & Grieve 1998) | Volume of ejecta (Collins 2005) | Efficiency, or Fraction of melt ejected (Warren 1996)

Contribution (%)



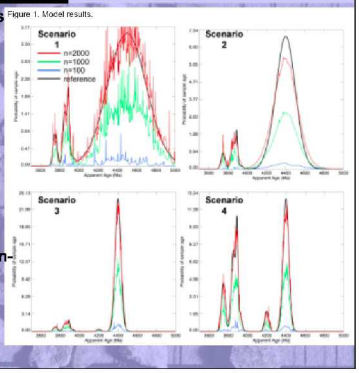
- If you randomly dated impact melt-rocks like pulling marbles out of this bag, what would the age distribution look like?

Statistical model

- Reference dataset: Age (A) of 7 basins
  - ± σA represents the range in real ages for a single event (e.g. slow cooling)
- Model dataset: 2000 impact-melt rocks apportioned according to the calculated melt fraction at the model site
  - Assigned a sample age from within the normal distribution σA
  - Assigned an uncertainty (U) associated with laboratory measurement

Model results (so far)

- Reference: 2000 particles
- S1: large σA small U
  - Discretized
  - False subpeaks
- S2: large σA large U
  - less discretized
  - Masks events with small ΔA
- S3: small σA small U
  - Only needs a few hundred samples
- S4: higher Pmelt from non-SPA basins
  - younger basins become more apparent



Conclusions and future work

- Still needed:
  - "noise" from young, local events
  - a statistical test by which individual impact event ages can be assigned to groups of samples, such as a simple signal-to-noise threshold or fit to a normal distribution function
- SPA-floor impact melt exists at interior landing sites and will be the dominant impact-melt rock type in any sample
- Corroborating information (petrology, elemental composition, regional context, RS) are important to correct interpretation
- Even if it weren't recognizable by geochemical or petrologic means, dating of a few thousand impact-melt fragments is still likely to statistically yield the age of the SPA basin