

# Lunar Impact Features and Processes

Co-Leads: Gordon Osinski (gosinski@uwo.ca), Jay Melosh (jmelosh@purdue.edu)

Tentative outline, LPI meeting, May 26, 2016

- 1) Preface: What is new since NVM-1
- 2) The basics of impact cratering (Osinski, Collins, Melosh, after Elements article)
  - A. Overview of the formation of impact craters.
  - B. Stages of impact cratering
    - Contact and Compression
    - Excavation
    - Collapse
  - C. Basic scaling of crater dimensions
  - D. Shock metamorphism and impact rocks
- 3) Methods of study
  - A. Observational (Spacecraft missions, especially the following)
    - Kaguya (Ol distribution, etc.) (Haruyama?)
    - LRO (LOLA, mini-RF, etc.) (Neish)
    - GRAIL (gravity probes beneath surface)
    - Chandrayaan (M3) (Pieters?)
    - Telescopic, ground-based radar, etc. (Ghent?)
  - B. Theoretical advances (hydrocodes, plus?)
    - iSALE (porosity, dilatancy, 2D, 3D) (Collins?)
    - CTH (3D, adaptive mesh)
    - SPH (3D, Self gravity—but probably not important for cratering)
  - C. Experimental
    - EoS experiments (anomalous heat capacity at high temperature)
    - Memin program comparing shock theory, experiments
    - TEM studies of shocked minerals
    - Shock indicators in lunar relevant minerals: pyroxene, plagioclase, etc.
  - D. Terrestrial (and other planets) analog studies (Haughton, Chicxulub, etc.)
- 4) Lunar craters and basins (from large to small)
  - A. Basins
    - Mantle uplift beneath large basins (Neumann)
    - Ancient, degraded basins from GRAIL Bouguer anomalies (Neumann)
    - Basin diameter vs transient crater solved!
    - Mascon origin finally solved
    - Ring tectonics validated (B. Johnson?)
    - Orientale, detailed gravity from GRAIL endgame, modeling (B. Johnson?)
    - Nearside/farside asymmetry a function of thermal state (Potter)

- Role of oblique impact, SPA special problems (B. Johnson?)
- B. Peak Ring and Protobasins
- Morphology transition from central peak to peak ring from LOLA data
  - Formation mechanics (Head/Baker group vs. hydrocodes)
  - Ring mineralogy (mid crustal origin in Schrödinger) (Kring?)
- C. Complex to Simple Craters
- Surprising positive Bouguer anomalies from GRAIL (Soderblom the younger)
  - Impact velocity, oblique impact role?
  - Role of target properties: porosity, slope, pre-impact topography
  - Highland vs. mare morphology (role of porosity?) (Milbury?)
  - Tycho: Melt distribution, LROC details (Denevi, Neish?)
  - Nature of rays, esp. Tycho from LROC
  - Shackleton depth puzzle
  - Possible retention of impactor material in central peaks, regolith
  - Melt distribution, dynamics in small craters (mini-RF findings) (Neish)
  - Strength/gravity transition in small craters, importance for age dates (van der Bogert)
  - Depth/diameter variations in small craters (Mahanti)
  - Ejecta blanket morphology (Dhinga)
  - Artificial craters from controlled spacecraft descent
  - Impact flashes
  - Recent impacts, splotches (Speyerer)
  - Ejecta plumes, vaporization

5) Shock metamorphism, melting, impactites

- Stress wave fragmentation, compaction of target rocks, spall
- Shock effects in plagioclase, pyroxene
- Melt rocks
- Ejecta dispersal, lunar melt spherules (Zellner)
- Impactites (Breccias, new classifications)

6) Unresolved/unclear questions for the future

- What is Procellarum basin (volcanic, impact)? (Andrews-Hanna)
- Role of thermal gradients, formation time, crustal thickness on crater morphology (Potter)
- SPA (nature of crust, gravity structure, magnetic anomalies, lunar figure, reorientation) (James?)
- Where is all the mantle olivine (re. Kaguya and M3 data)
- Details of ring fault formation, localization on faults
- Seismic efficiency of impacts (Richardson?)
- Is self-cratering real? (Plescia, Zanetti?)
- Melting at the antipode of large impacts, esp. SPA