Unusual Craters: The Weird and the BizzZZZarrrrre on the Moon
Outline
I. Impact Mechanics
II. Unusual Crater forms on the Moon
   1. Oblique Impacts
      a. Ejecta Abnormalities
      b. Crater Abnormalities
      c. Look Alikes
   2. Simultaneous Impacts
      a. Binary Impacts
      b. Crater Chains
   3. Dark Haloed Craters
      a. Fire-fountaining
      b. Dark Mare Exhumation
   3. Concentric Ring Craters
   4. Square Craters
   5. Floor Fractured Craters
III. Other Terrestrial Worlds
   1. Mars
   2. Venus
Impact Mechanics
Crater Copernicus
CLA D19

Terms
1. Central Peak
2. Floor
3. Terracing
4. Rim
5. Continuous Ejecta
6. Discontinuous Ejecta
7. Secondary Cratering
8. Bright Ray Pattern
Stages of Crater Formation

1. Contact and Compression
   a. Velocity
   b. Kinetic Energy
   c. Shock wave
   d. Vaporization, Melt, Shock, Fracture
   e. Jetting, Spallation

2. Excavation Phase
   a. Rarefaction Wave
   b. Transient Crater
   c. Ejecta Patterns
   d. Point transfer

3. Modification Phase
   a. Slipping
   b. Central Peak formation
   c. Terrace formation
   d. Landslides

Crater Formation
Traces of Catastrophe, French, 21.
Crater Copernicus

CLA Div
Oblique Impacts
Copernicus Rays

CLA Div
Tyco Rays

CLA Giii
Crater Migration in Oblique Impacts
IP = impact point; CC = center of final crater

Crater Migration

Experimental Ejecta Curtains

1 km/sec bolide in a vacuum at 90, 45, and 30 degrees

Oblique Impacts
AS 15-9337p
AS 16-4511p
Proclus
CLA Ci
Impact less then 5 degrees
AS 15-9254p
Oblique Impact on Mars

Craters Messier and Messier A
CLA E3, Ei
Messier Ejecta
Wilhelms, The Geologic History of the Moon, 38
LOv-5041-m
Experimental Oblique Impacts
Messier Craters

Possible Explanations
1. Separate Projectiles
2. Binary Projectile
3. Decapitation, Ricochet
4. Local geology
Secondaries of Langranus
CLA E4
Secondary Craters of Crater Copernicus
LOiv-148m, iv-142m, iv-144m
Crater Endymion
CLA A1
Rectified Lunar Atlas, 8b
Simultaneous Impacts
Binary Impacts

Wilhelms, The Geologic History of the Moon, 33
Bessarion A
LO iv-144h
Imbrium (Plato K, KA), Clavius (unnamed)
LOv-102m, iv-136-h1
Abulfeda Crater Chain
CLA F8, LOv-184m
Endogenous Chain (near Gruithuisen)

LOV-183-m
Dark Haloed Craters
Dark Haloed Crater Types

LOiii-164m, 146m, Ranger 9 (cf. Head, LPSC 1975, 6.349-351).
Cinder Cone, Hawaii
Cinder Cone on the Moon
AS17-M-305
Dark Haloed Craters in Alphonsus
Ranger 9 images
Dark Haloed Craters
Theophilus (CLA E5, E7, AS 16-029M), Copernicus (CLA D19)
Concentric Ring Craters
Crater Hesiodus
LOiv-120-h1
Concentric Ring Craters, Intermediate Forms
LOiv-101-h3
Concentric Ring Craters (Lavoisier, Repsold)
Loiv-189-h2, Loiv-189-h3
Concentric Ring Craters
Crater Marth
CLA F20, LOiv-136-h3
Floor Fractured Craters
Floor Fractured Craters
LOiv-189-h2, LOiv-189-h3
Crater Petavius
USAF Lunar Atlas 1 A6-b, CLA F2, LOiv-184-h2
Crater Petavius

LOv-035-m
Crater Atlas
CLA A1, Smart-1
Crater Atlas
Gaddis: LPSC 43 (2012), 2787
Craters with Volcanic Components
AS17-M-0834, LOv-183-m
Non-Circular Craters
Barringer Crater

Shane Torgerson
Oddly Shaped Craters
LOiv-101-h3
Other Terrestrial Planets