

## 105 Chapter 4 Review Notes – Part 1 – Impact Cratering

- *Impact cratering* is the most pervasive planetary surface process in our solar system
  - *Hypervelocity* impacts of materials from space onto planetary surfaces
    - Velocities of 10s of km/sec (~10-70)
    - Explosion craters
    - Typically round, except at very low *incidence angles* (<3° or so)
    - Impactor vaporizes
    - Target rock (material on surface that gets hit by impactor) gets vaporized, melted, highly shocked/fractured
  - ***Ejecta blanket*** is the layer of debris thrown out of the crater that piles up around it; reverse order w.r.t. underlying rock layers excavated
    - Underlying rock layers 1, 2, 3 (bottom to top), will be topped with fragmental layers 3, 2, 1 (bottom to top) because progressively deeper material is excavated after the upper layers
    - Continuous ejecta is complete cover of surface by loose debris in area immediately outside the crater rim
    - Discontinuous ejecta is partial cover of underlying surface by spotty areas of loose ejecta debris; more distant than continuous ejecta
    - Crater rays are bright linear disturbances of underlying rocks by clumps of ejecta thrown out to extremely large distances from the crater; more distant than continuous or discontinuous ejecta (though it's sort of the outermost part of the discontinuous stuff)
  - Crater floors can be filled with *impact melt*, a deposit of molten target rock that cools and solidifies much like a lava flow
  - Intense, instantaneous pressure waves from impact event cause *shock metamorphism* in rocks and minerals locally, which are distinctly different from pressure effects from regional metamorphism/mountainbuilding (different minerals and fracture patterns)
  - Impacts can produce craters at all scales, from microscopic to 1000+ km across
    - Planetary atmospheres can block smaller-scale impacts
      - Microscopic ones occur only on “airless” bodies like the Moon
      - Thicker atmospheres block larger projectiles
        - Venus has no impact craters smaller than about 1-2 km
        - Earth has none smaller than tens of meters or so
  - The smaller the impactor, the larger the number of them available (based on crater size-frequency distributions; result of collisional debris – think of dropping and breaking a glass)
  - Craters become more complex at increasing diameters
    - “simple” bowls → terraced craters → central peaks and terraces → peak rings → multi-ring basins
  - Larger craters have shallower depths w.r.t. their diameters than smaller ones
  - More craters on a surface indicates a greater age of that surface
  - Impactor source regions include near-Earth asteroids (NEAs), main asteroid belt, Kuiper Belt (comets), and the Oort Cloud (comets; theoretical)

- Surface processes on planets/moons/small bodies may include gradation (erosion and deposition) by gravity, wind, water and/or ice; volcanism (eruption of lava and/or ash from the interior); tectonism (up, down, or sideways motion of blocks of surface rocks along faults and/or bent “folds”); and impact cratering
- In order for a planet to have gradation beyond gravity-driven mass wasting (e.g, landslides), it is necessary for the planet to have an atmosphere
  - Precipitation of water (or any other fluid) that falls and then runs downhill over the surface) appears to be a dominant gradational force on the planets (Earth, Mars) on which it occurs. Flowing methane may play a similar role on Saturn’s largest moon, Titan
- Wind erosion/deposition also requires an atmosphere, as wind is atmospheric motion over the surface
- Erosion by the scraping of glacial ice has occurred on Earth many times, and may well have occurred on Mars, as well, since plenty of water ice is available there still today
- Landslides occur on all types of solid bodies – since only *a slope and gravity* are needed. On many bodies the primary trigger for landslides is probably shaking from nearby meteor impacts.
- Earth and Mars show evidence for all types (cratering, volcanism, tectonism, gradation) of processes having occurred during their histories. Titan probably also has experiences all 4, albeit with methane taking the place of water. Bodies large enough to be differentiated (over 500-1000 km or so in diameter) commonly show evidence for volcanism – all the terrestrial planets, several of the larger moons (Io, Triton, Titan (probably), and at least one of the largest asteroids show evidence for volcanism renewing their surfaces.
- Plate Tectonics is a process that appears to be unique to Earth, but faulting, fracturing and other tectonic activity (mountain belt formation) occur on many of the larger terrestrial bodies, especially Venus.
- Landforms suggestive of fluid flow/runoff include river channels (especially “dendritic” ones), streamlined islands, meanders, and deltas/fans.
- Landforms indicating wind include dunes, storms, and dust devils
- Volcanoes, rings of ash, lava channels and flows are indicative of volcanism
- Linear fractures and mountain belts/chains, as well as straight-sided valleys and offset landforms are indicative of tectonic forces/tectonism