

Planetary Surface Processes

Cratering

Gravity

Tectonics

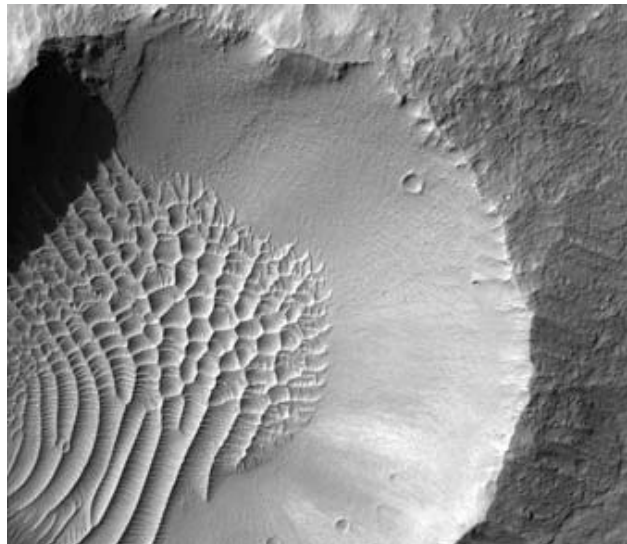
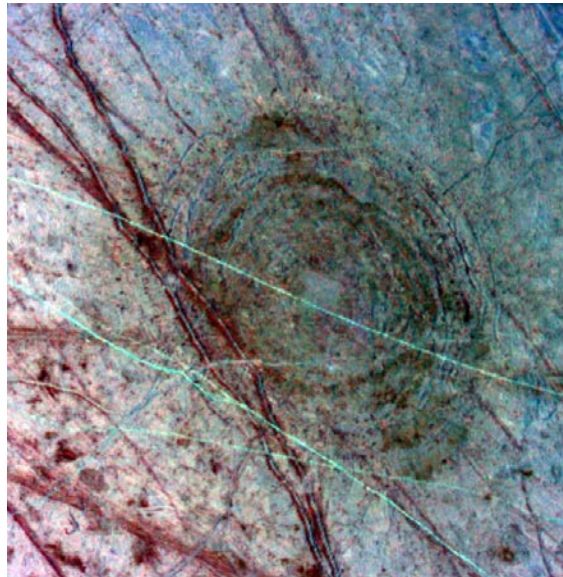
Volcanism

Winds

Fluvial

Glacial

Chemical
weathering



Gravity & Rotation

Polar flattening caused by rotation is the largest deviation from a sphere for a planet sized object (as opposed to non-spherical objects that miss the planetary cut-off due to insufficient self gravity).

For some solar system bodies:

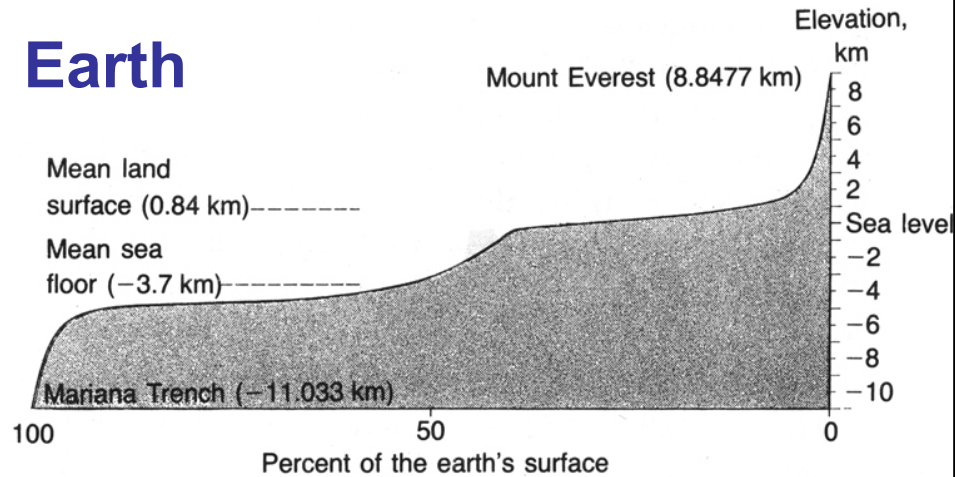
Saturn 1:10, Jupiter 1:16,
Earth 1:298, Moon 1:900,
Sun < 1:1000

$$f = \frac{a - b}{a}$$

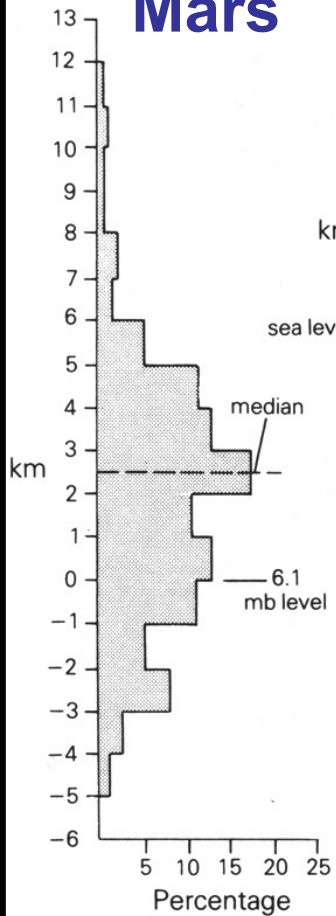
a is the equatorial radius,
 b is the polar radius

Planetary Hypsometry

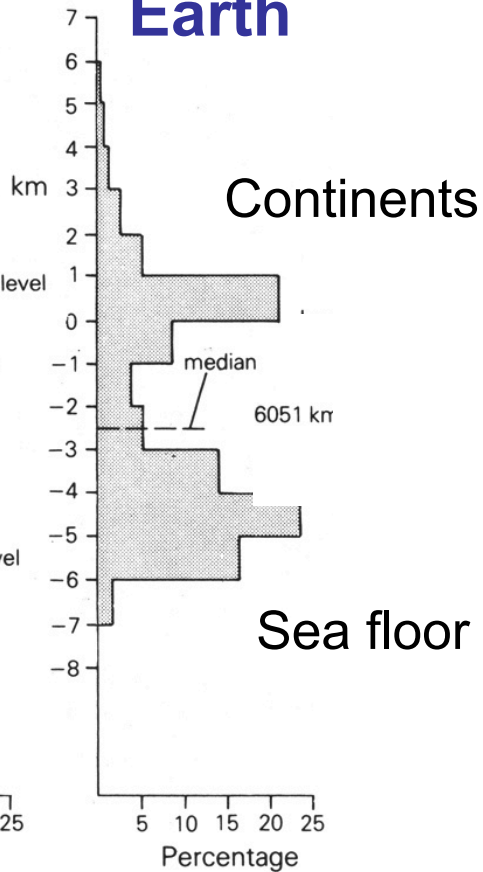
Earth



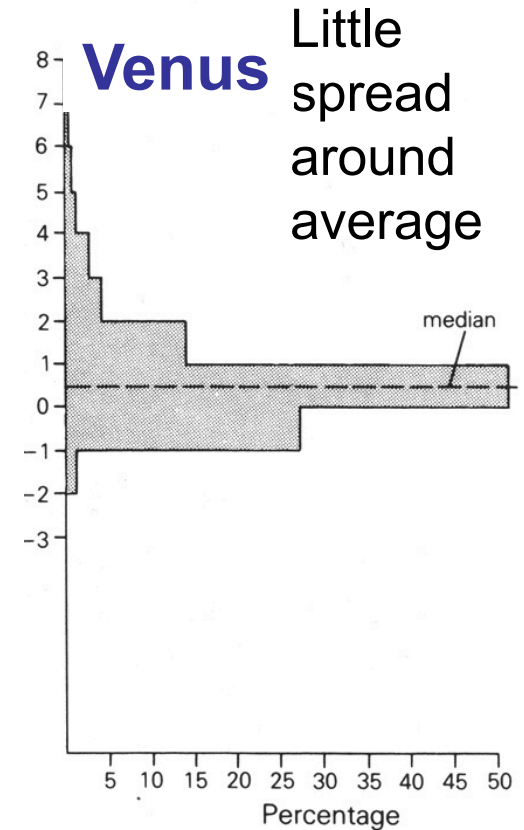
Mars



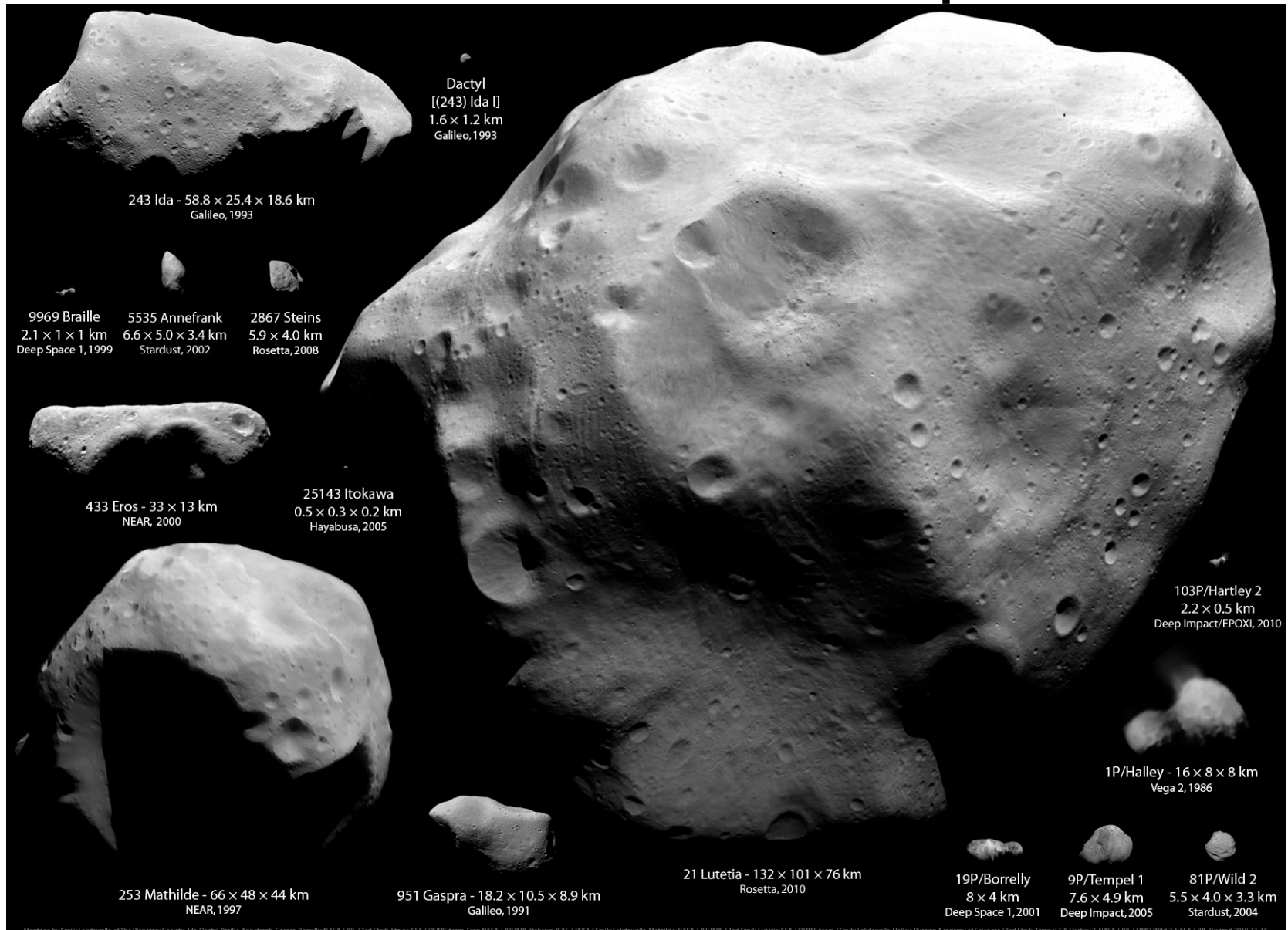
Earth



Venus



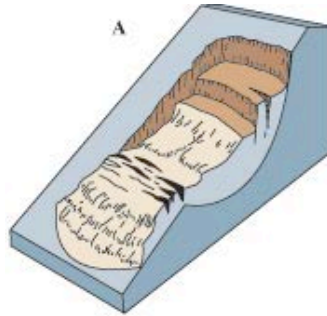
Smaller bodies are not spherical!



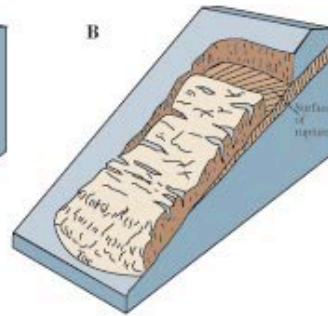
Asteroid Itokawa



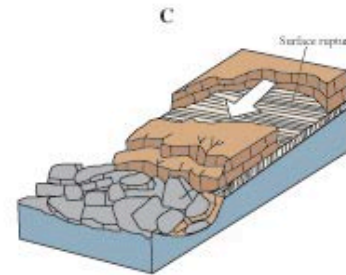
Some types of mass wasting



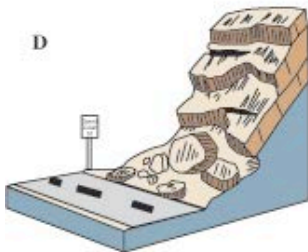
Rotational landslide



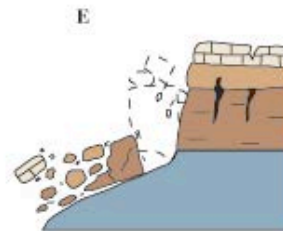
Translational landslide



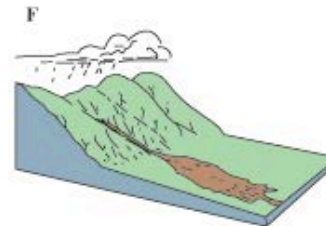
Block slide



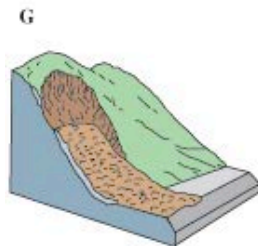
Rockfall



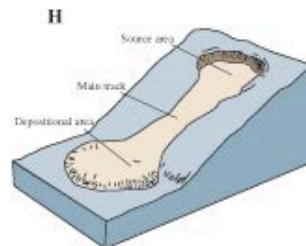
Topple



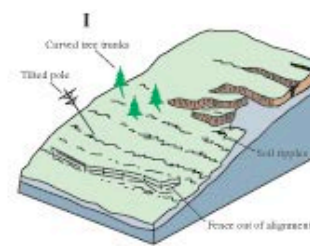
Debris flow



Debris avalanche



Earthflow



Creep

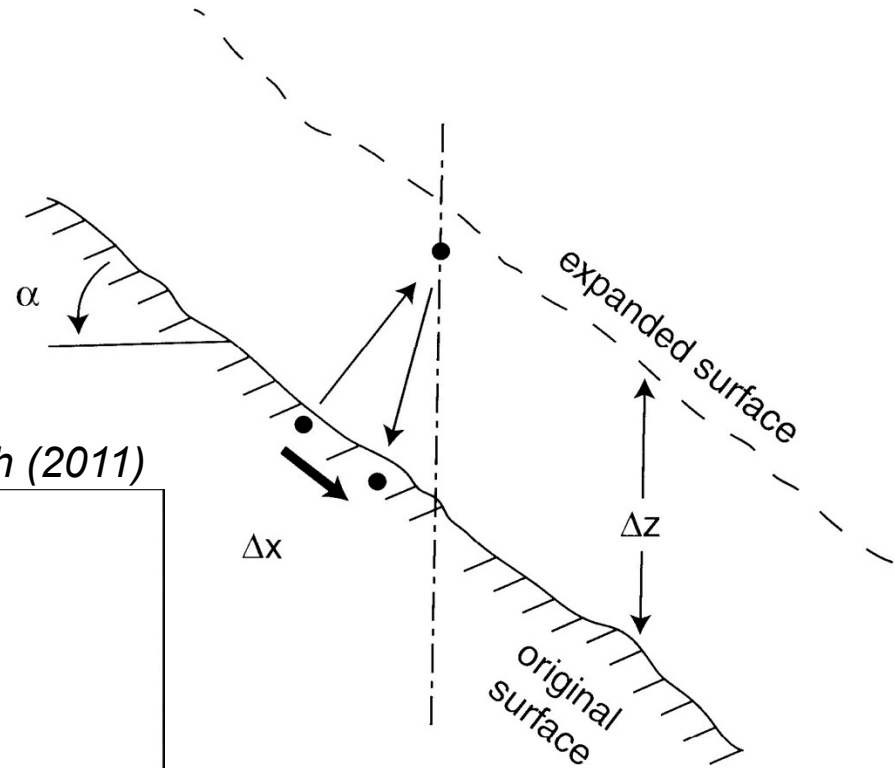
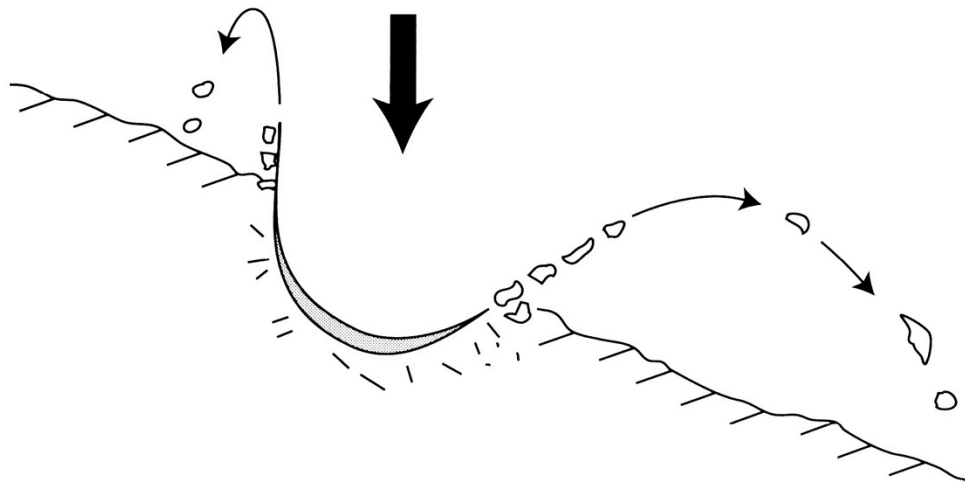


Lateral spread

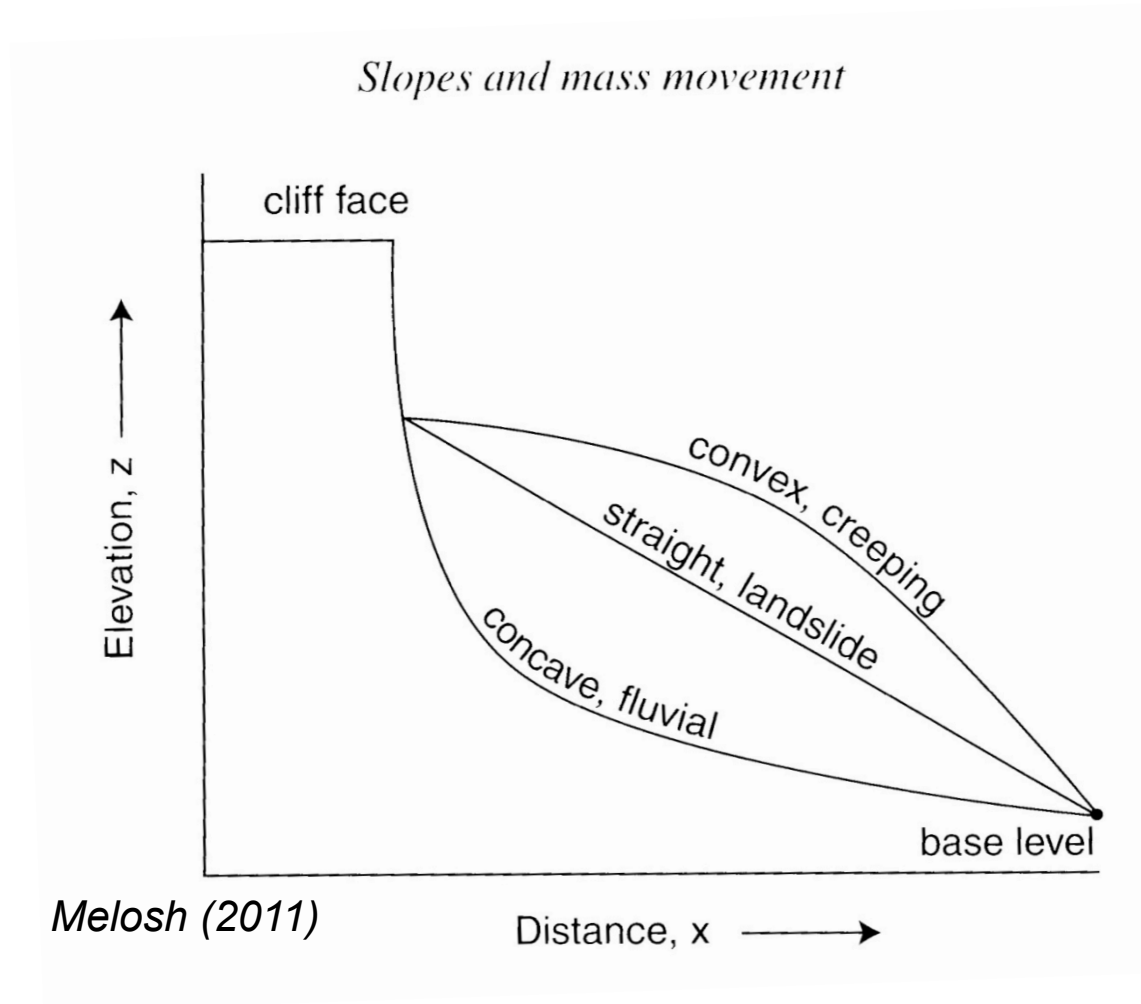
Creep: **slow**, incremental mass wasting

Melosh (2011)

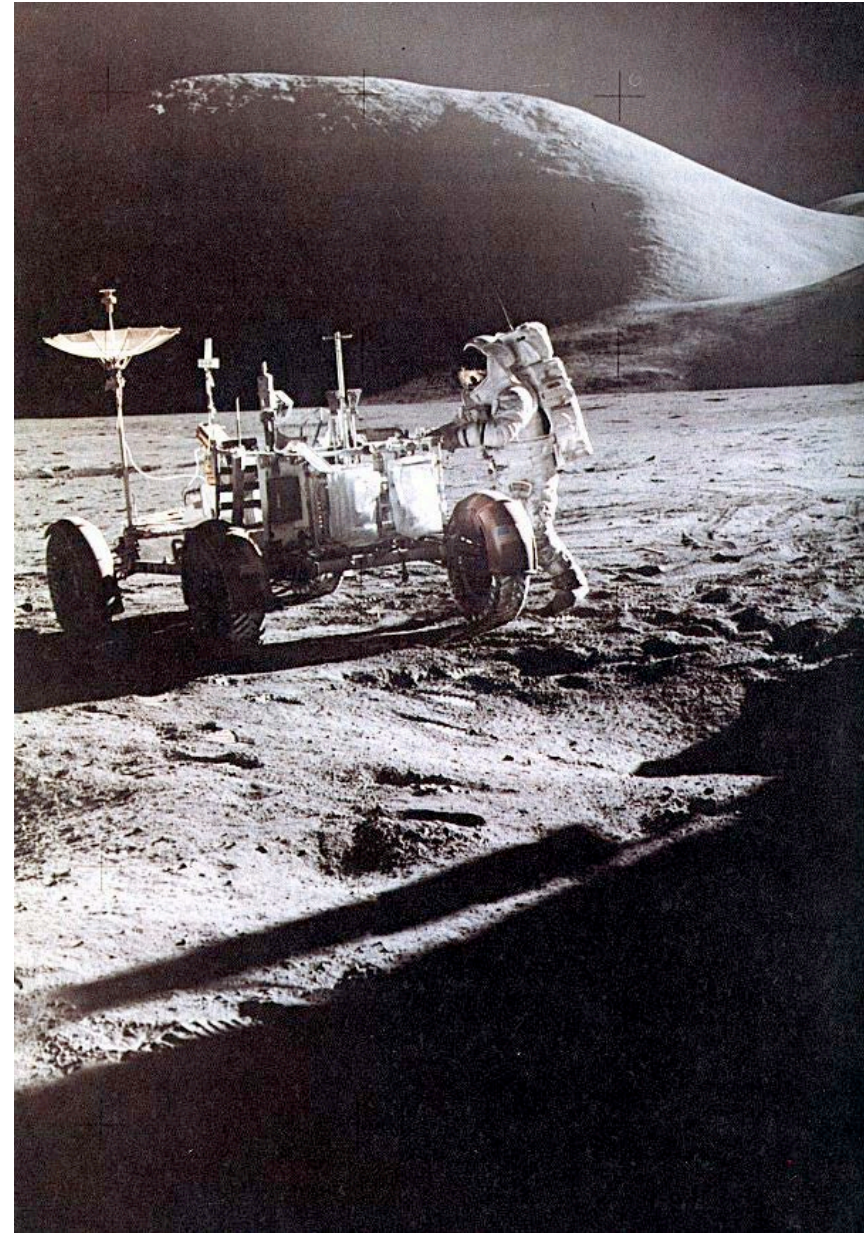
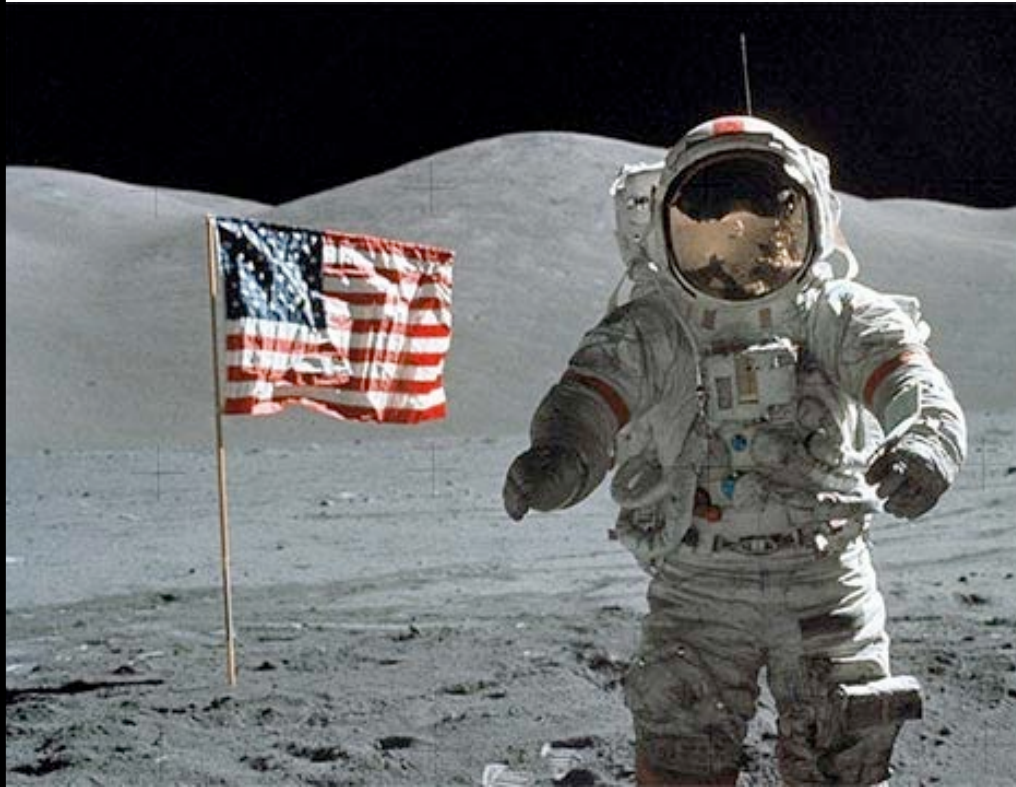
Slopes and mass movement



Slopes formed by creep vs. other processes



Lunar creep-dominated landscapes



Mass wasting

Affects slopes steeper than ***angle of repose***

→ *related to internal friction angle*

Table 8.1 *Angles of internal friction*

Material	Angle of internal friction
Basalt talus	45°
Granitic gneiss talus	31–36°
Alluvium	41–44°
Glacial till	37°
Shale grit	43°
Sand	33–43°
Silt	32–36°
Cold water ice (77–115 K) ^a	29°

Data from Carson and Kirkby (1972) unless otherwise noted.

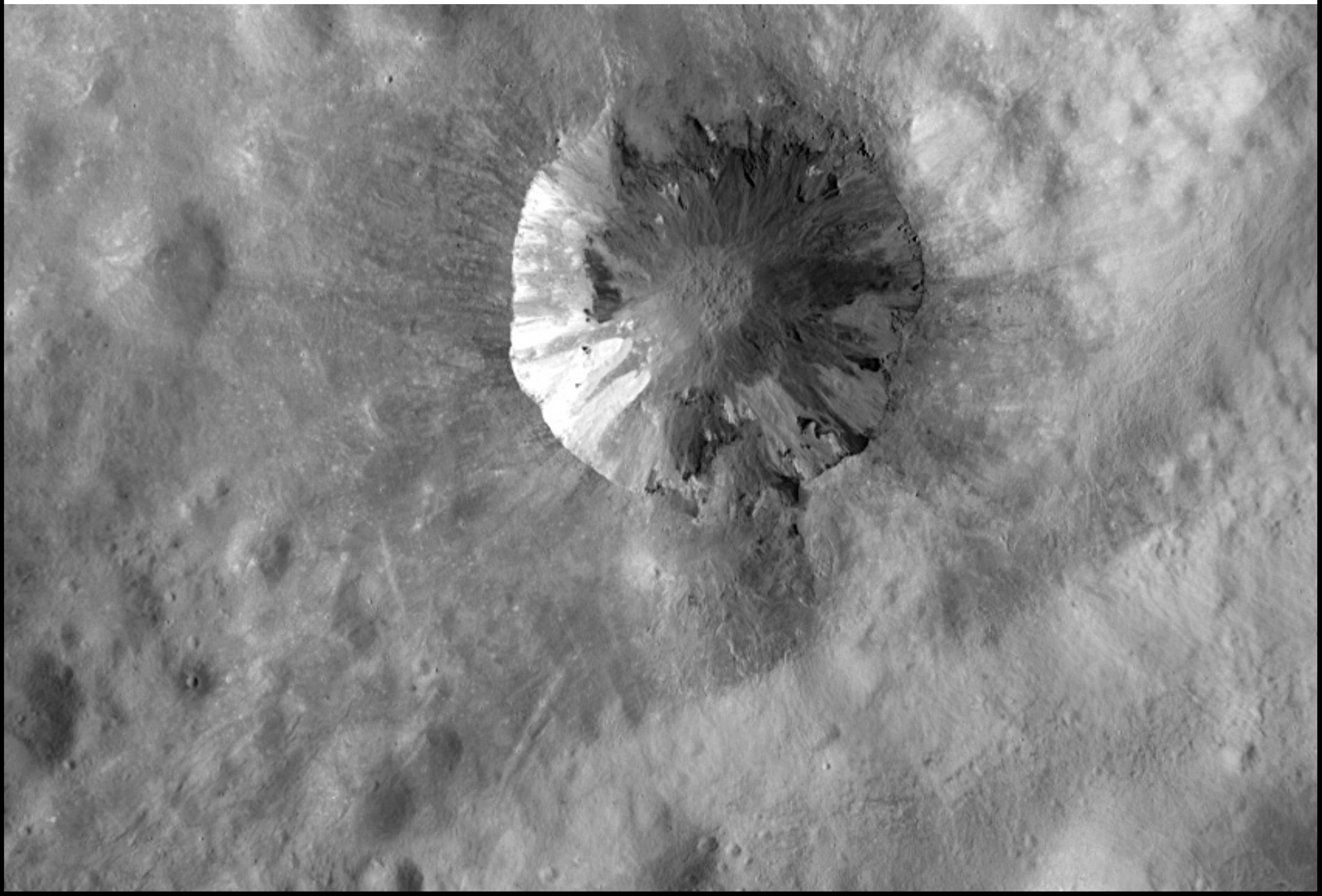
^a Beeman *et al.* (1988)

Melosh (2011)

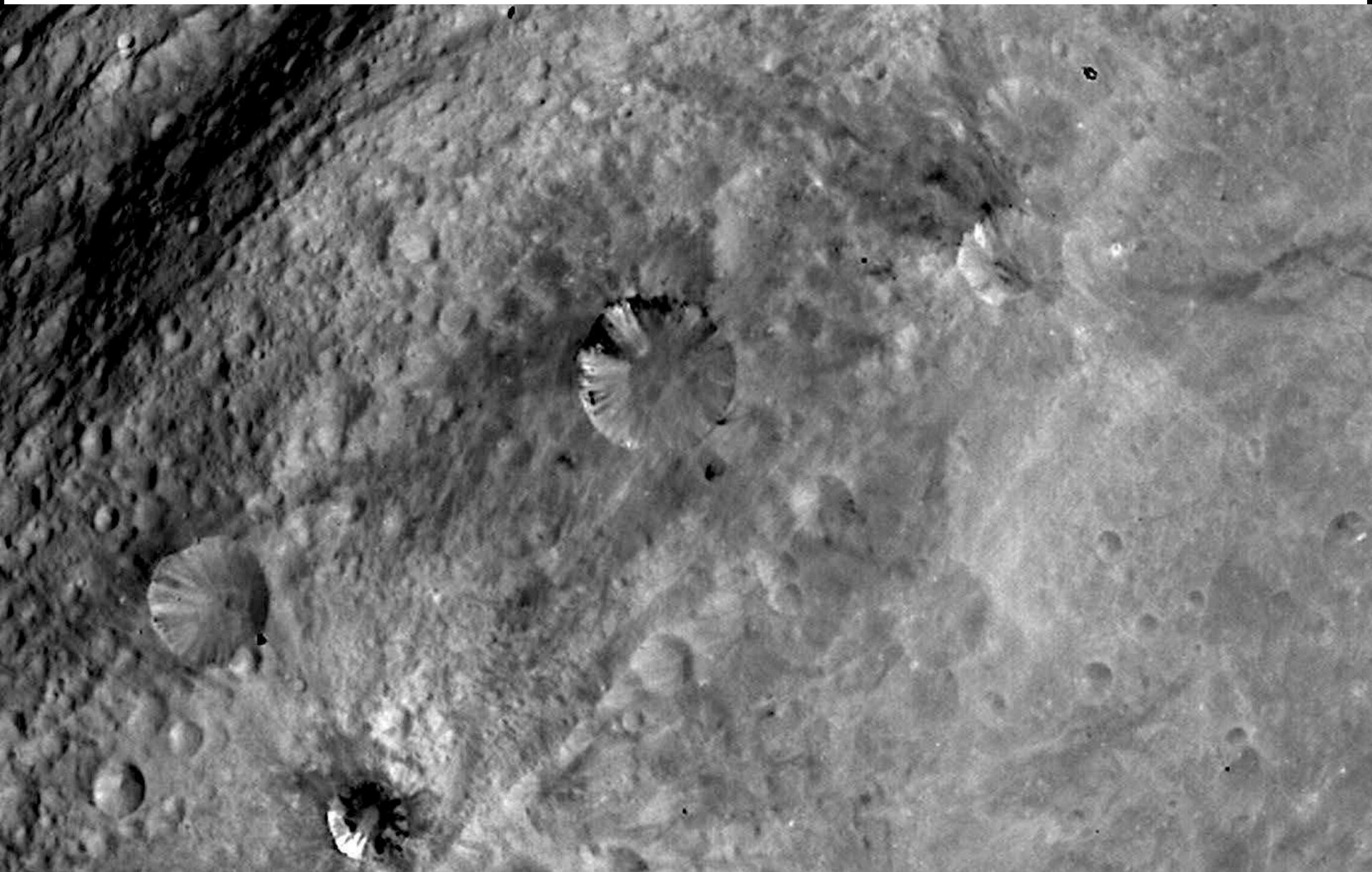
Martian rockfalls



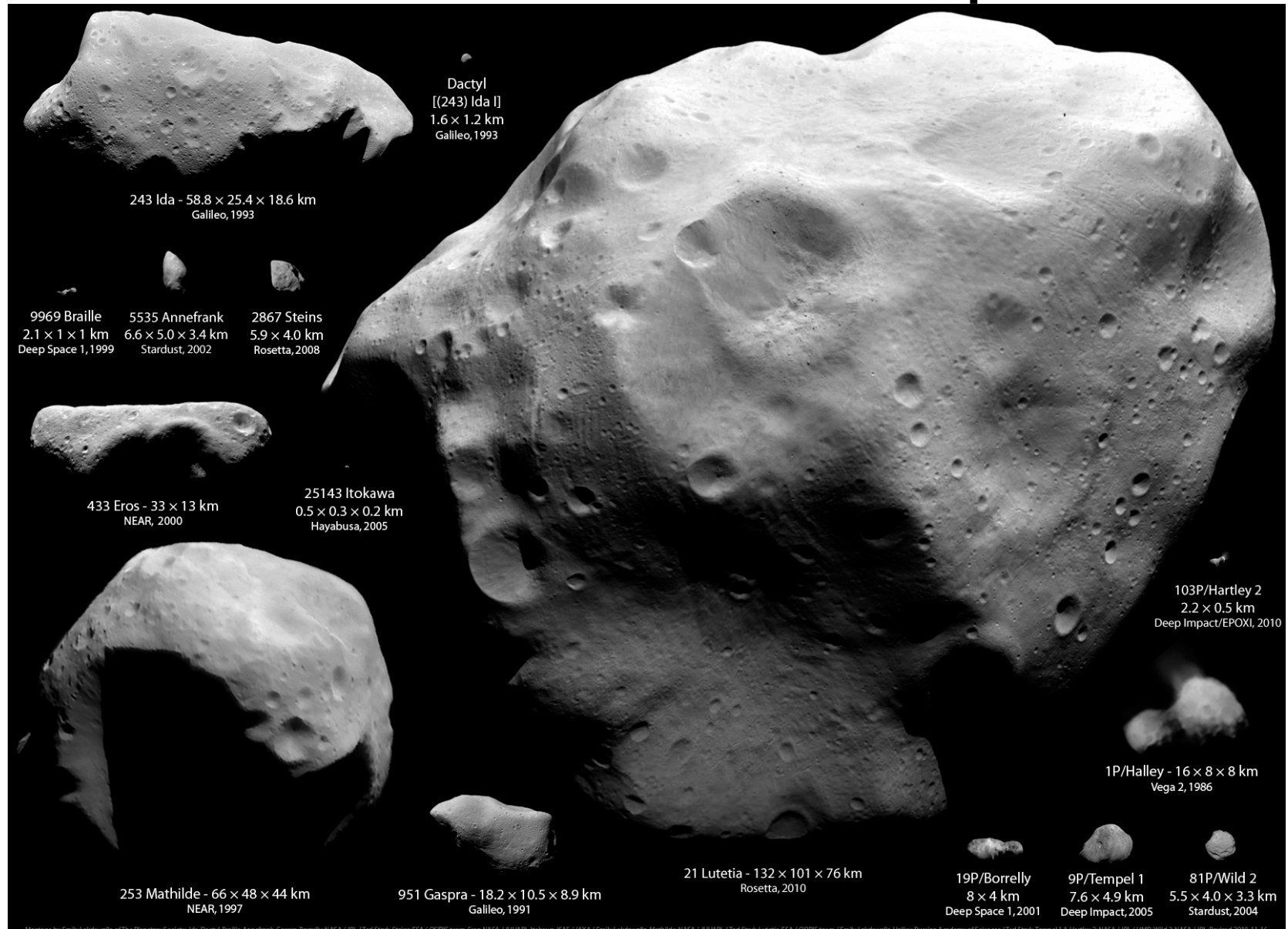
Mass wasting on Vesta



Mass wasting on Vesta

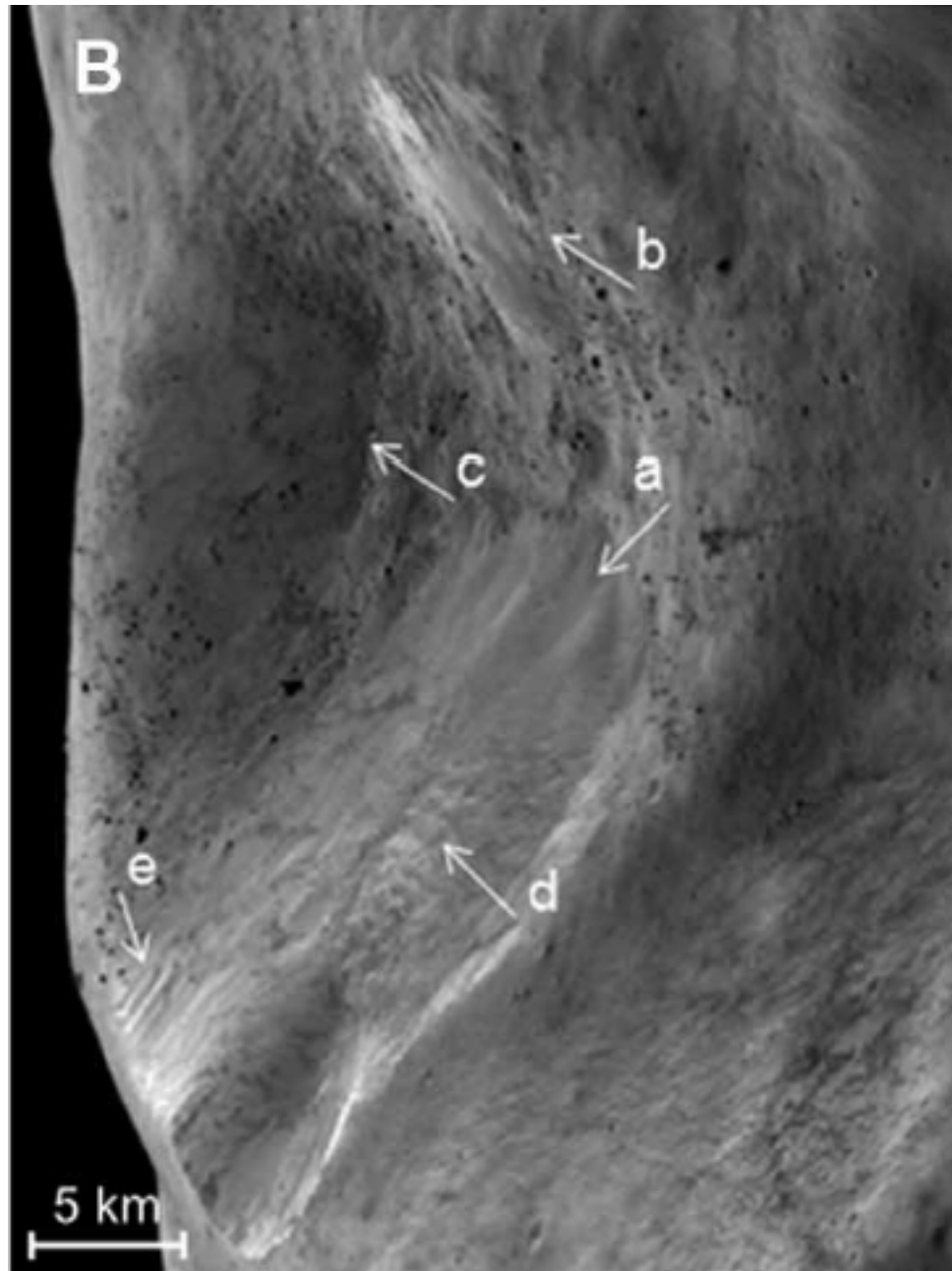


Asteroids & comets visited pre-Vesta



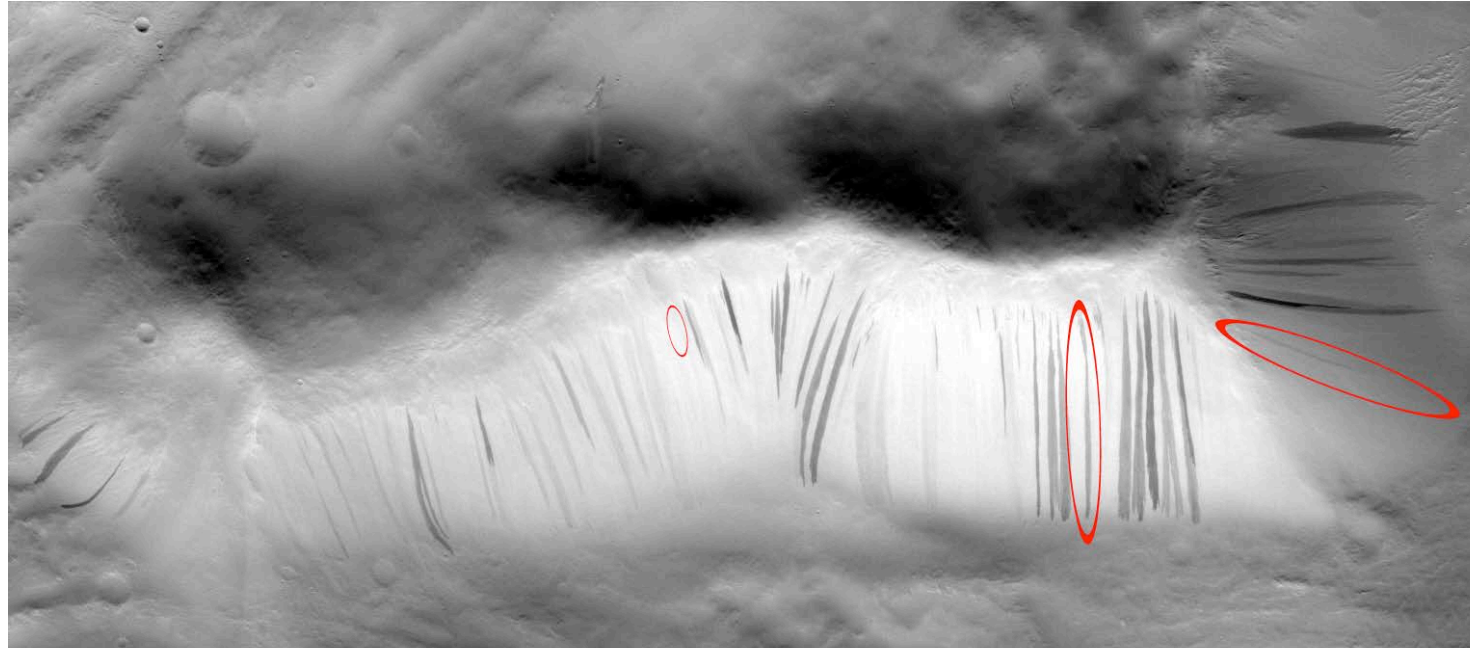
Montage by Emily Labergha of The Planetary Society. Ida: Dactyl/Braille: Annefrank: Gaspra: Borrelly: NASA / JPL / Tiedtke; Steins: ESA / OSIRIS team; Eros: NASA / JPL/NEAR; Itokawa: JAXA / Hayabusa; Mathilde: NASA / JPL/NEAR; Lutetia: ESA / OSIRIS team; Eros: JPL/NEAR; Hayabusa: JAXA / Hayabusa; Rosetta: ESA / OSIRIS team; Tempel 1: NASA / JPL / DLR; Wild 2: NASA / JPL / DLR; Stardust: NASA / JPL / DLR; 2010-11-16.

Lutetian landslides

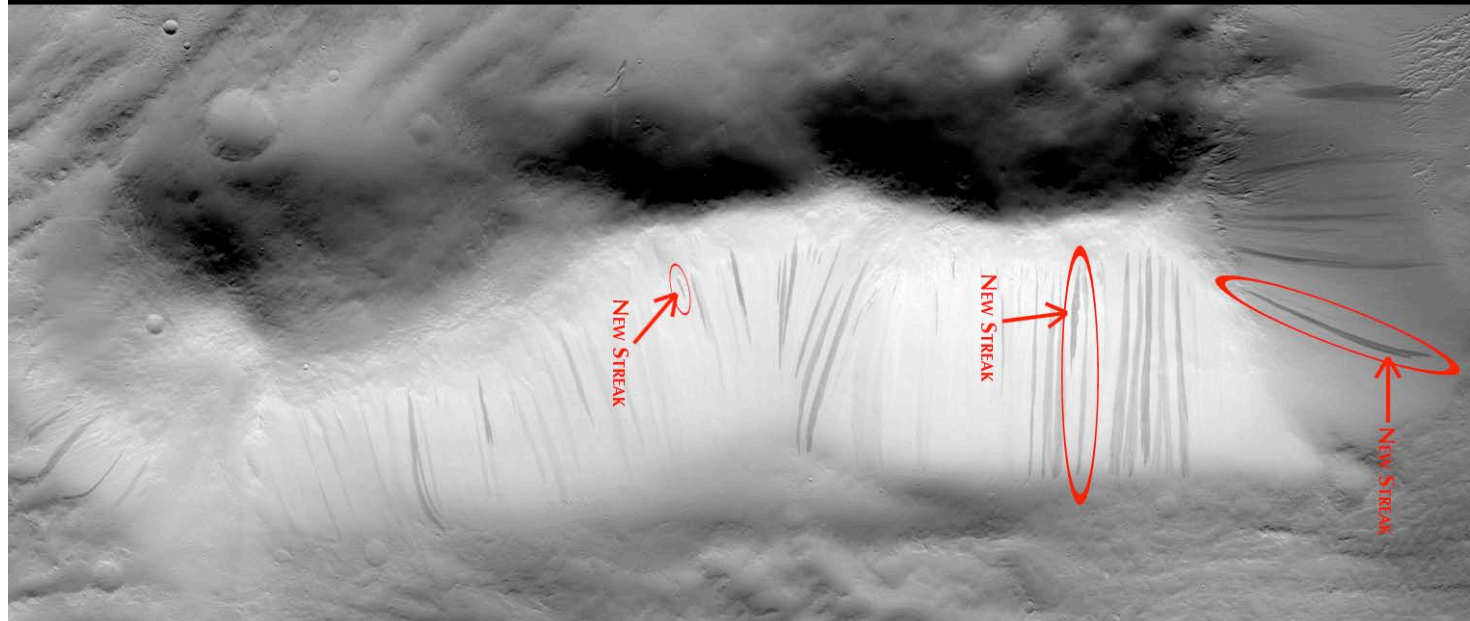


Sierks et al. 2011

Mars dust avalanches forming, fading



MOC E04-01817

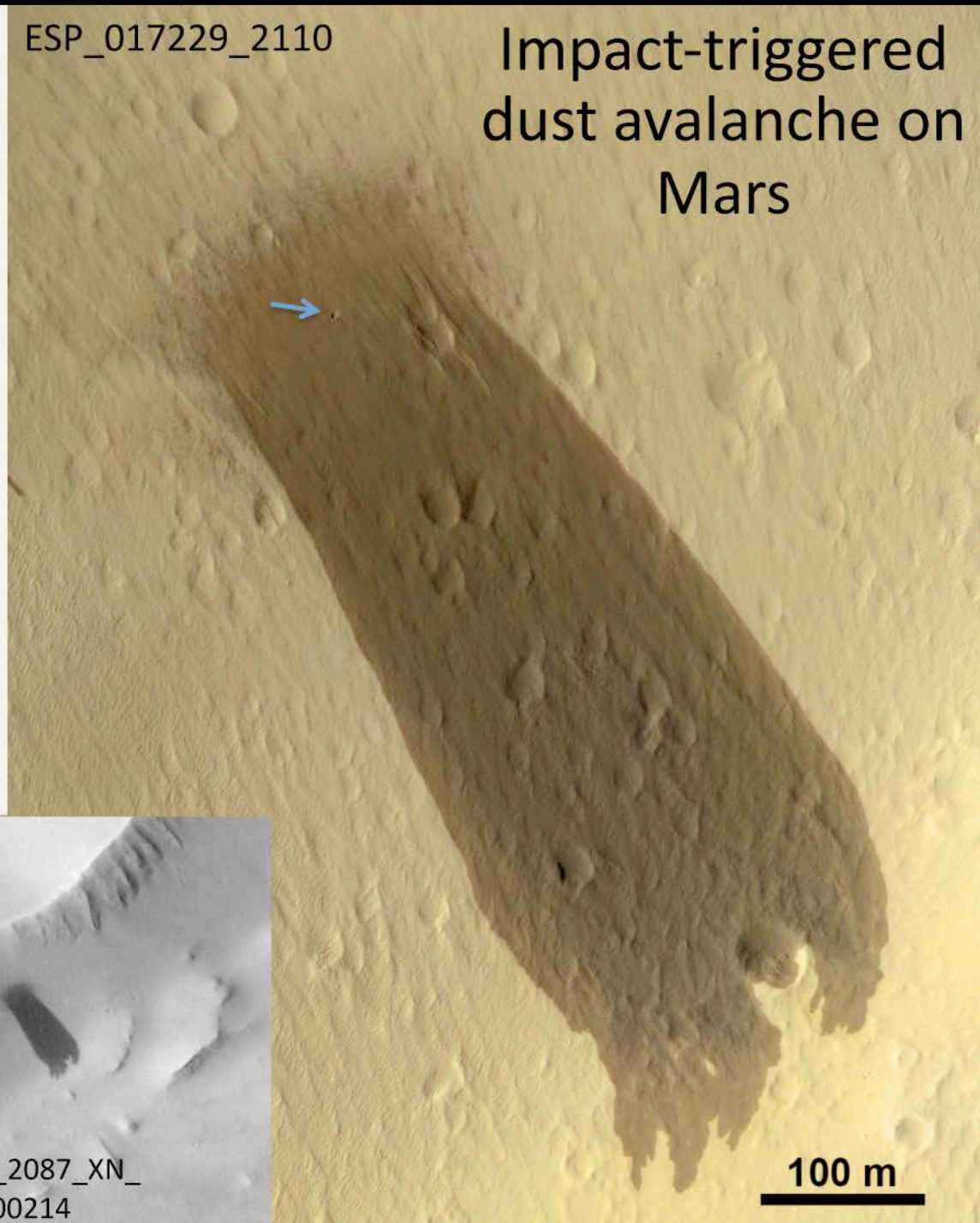


HiRISE PSP_002396_1900

MRO's Context camera (CTX) acquired the image at lower left on Nov 18, 2007 and the adjacent image on Feb 14, 2010, showing a large new slope streak in the aureole (giant landslide deposits) of Olympus Mons. Slope streaks (dust avalanches) are common on Mars but this one is unusually wide and it began from an unusual extended/fuzzy source area. HiRISE acquired the follow-up image (right) March 31, 2010, revealing a small, pristine impact crater (blue arrow) in the fuzzy source area, which resembles the airblast patterns seen at many other new (recent year) impact sites. We conclude that an impact event occurred sometime between the dates of the CTX images and triggered a large dust avalanche.

ESP_017229_2110

Impact-triggered dust avalanche on Mars



P13_006153_2133_XN_
33N141W_071118

B18_016662_2087_XN_
28N140W_100214

100 m