The origin of asteroids

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Introduction

The purpose of this account is to open a fresh viewpoint for discussion on a major astronomical problem: the origin of asteroids.

The writer applies term ”asteroid” collectively to a group of celestial objects such as near-Earth asteroids, comet nuclei, and the martian moon Phobos. The Asteroid Belt proper is not included or addressed.

New comet nucleus images recently became available. Since the writer cannot access primary data, the attached images were adopted, and later cropped and processed, from public sources. To the writer's knowledge geological interpretations on asteroids, such as those presented in this paper, were not previously carried out.

The origin and composition of asteroids is poorly understood and explained. They are generally thought to originate from a gas-rich dust disk around the young Sun. However, to a geologist, asteroid images tell stories that astronomers may not be familiar with. In the following, geological features identified in Figs. 1–7 will be described and discussed. Conclusions will be drawn accordingly.

Discussion

Primary sedimentary layering and subsequent stress fracturing could not form in open space but needed a solid voluminous platform. Stone and iron meteorites could not selectively condense in space, but needed a heavy enough parent body for gravitational differentiation. Comet nuclei containing layered ice needed a planet-size depositional platform, with evaporation in unfrozen oceans and an atmosphere thick enough for precipitation based on air circulation.

Albedo variations in remote asteroids most likely result from their geological evolution: rock breaks along fractures and rock type contacts. Resulting fresh surfaces preferentially reflect light. Asteroids with variable albedo are just another indication for a major collision that took place early in the history of our solar system.

Lander(s) should be launched to fetch asteroid material for mineralogical, dating, geophysical and biological determinations. Magnetism, remanent in lava flows, would tell whether the collision occurred in a polar or equatorial region. Phobos will be sampled by the Fobos-Grunt robotic mission in near future.

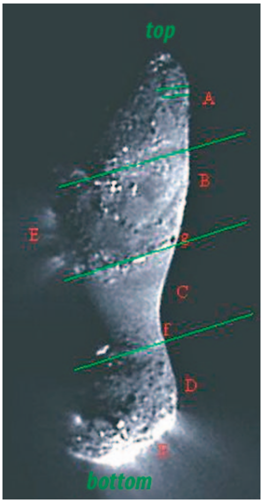


Fig. 1. Hartley2 comet nucleus. Image: NASA/JPL-Caltech/UMD

The nucleus appears to be composed of volcanic-sedimentary and glaciogenic materials. Green lines mark the general strike of primary layering. Grading (at "f") indicates that basin bottom is down, layer tops are up.

- *Lowermost (at D) there is a c. 500 m thick volcanogenic formation. Intense fracturing diffuses uniform layering, c. 20 m in thickness. Some of the material may be pillow lava.*
- *At C we have a half-kilometer thick formation of compact, relatively high-albedo material, possibly water ice mixed with volcanic ash. Recrystallization obscures primary layering which, however, remains detectable. The Sun erodes this formation more intensely than those composed of rock.*
- *Formation B is made of chaotically deposited material. Individual layers look like slumped down suggesting faulting (earthquake) in the vicinity.*
- *Formation A: Towards top, uniform 20-m layering gradually resumes.*

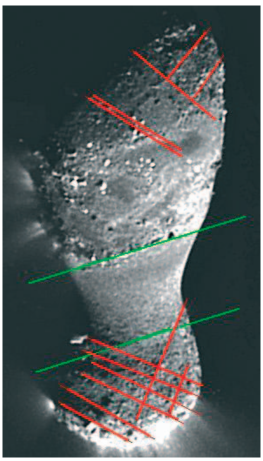


Fig. 2. Hartley2 comet nucleus. Image: NASA/ JPL-Caltech/UMD

The image displays a stress fracture pattern resulting from nonhydrostatic weight. There must have been more layered material, likely several kilometers in total thickness, above this chunk that eventually became a comet nucleus. Fracturing cuts material into pieces causing displacement in originally uniform layers.

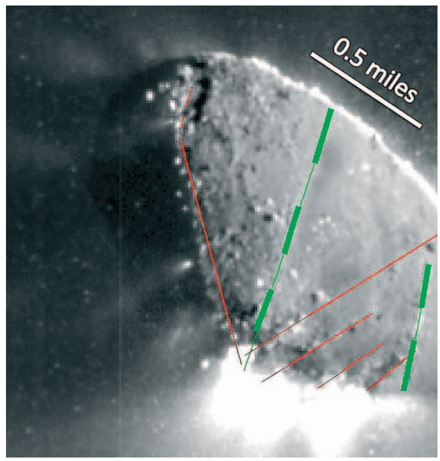
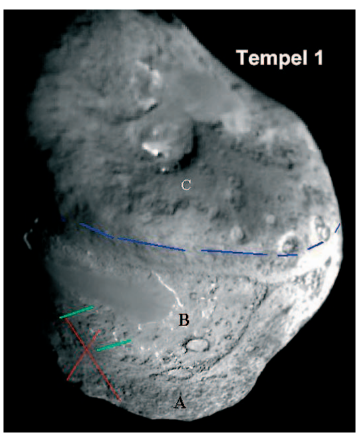


Fig. 3. Hartley2 comet nucleus. Image: NASA/ JPL-Caltech/UMD

Jets spurt from major fracture zones – natural aquifers – and specifically from areas where fractures cross each other. The snow balls likely originate from vapors condensed in space, droplets pulled together by gravity and rained back on the nucleus.

Fig. 4. Tempel1 comet nucleus. Credit: Univ. Maryland, JPL-Caltech., NASA

The image displays primary layering (blue) and load fracturing (red). An advancing glacier scoured a trough (B) in a previous, even wider trough (A). Later, after the glacier had retreated, the 2.5 km deep fjord was chaotically filled with rounded moraine boulders, ice rafts and glaciogenic debris. An iceberg (c. 500 m thick, 3–4 km long) was trapped in the bay. Cross bedding occurs in fill material at trough center (green). The fjord displays u-shaped bottom, an erosion feature typical of glaciated terrains. The overlying dark layers (C) likely contain volcanic ash (glass shards, color of blackish obsidian, low in albedo). Tops up, bottom down.



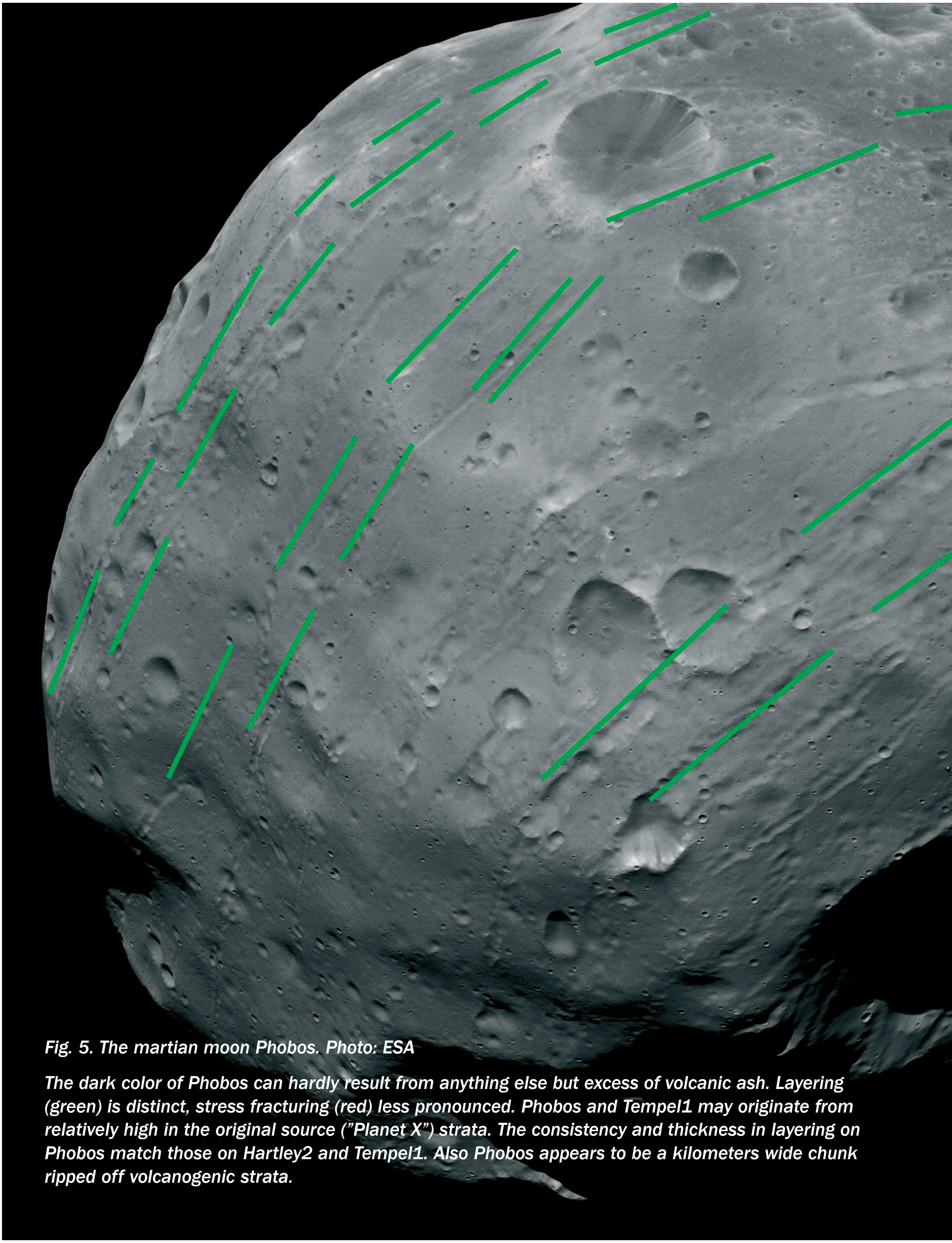
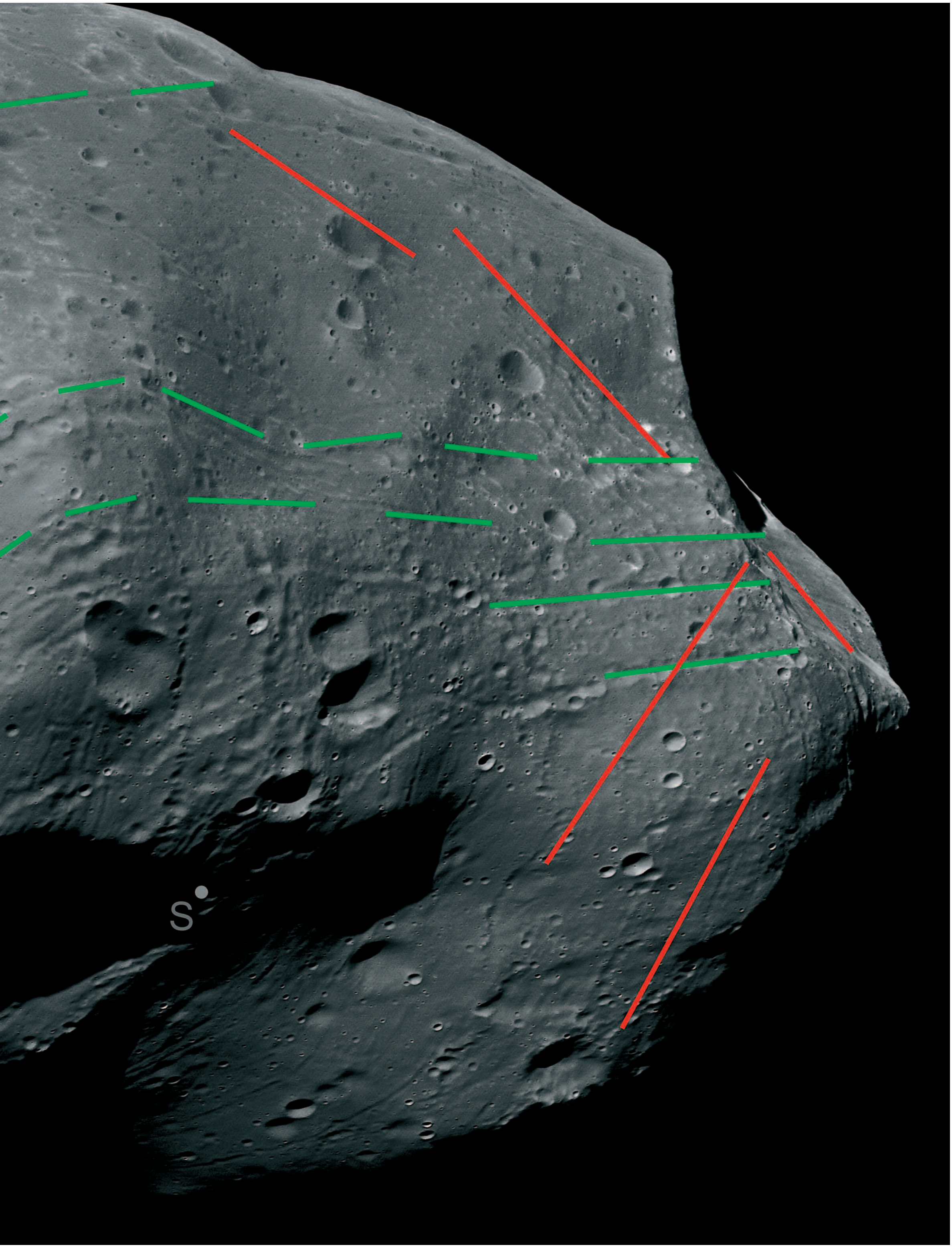


Fig. 5. The martian moon Phobos. Photo: ESA

The dark color of Phobos can hardly result from anything else but excess of volcanic ash. Layering (green) is distinct, stress fracturing (red) less pronounced. Phobos and Tempel1 may originate from relatively high in the original source ("Planet X") strata. The consistency and thickness in layering on Phobos match those on Hartley2 and Tempel1. Also Phobos appears to be a kilometers wide chunk ripped off volcanogenic strata.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What and where was the mysterious “Planet X”? This is known of it:

- Planet X orbited our Sun within the life zone: there was liquid water (Fig. 4) that must have gathered into seas. There was dry land, as well (Fig. 7).
- Geologically, Planet X was active: volcanoes erupted lava, ash and plateau basalt (Figs. 5 and 7). Faulting shook the ground (Fig. 1).
- Polar regions were glaciated: ice deposited in layers (Fig. 1), an iceberg was trapped in a fjord filled with glaciogenic material (Fig. 4). Since continuous precipitation did occur, equatorial regions must have remained unfrozen for evaporation.
- Planet X had a primitive atmosphere. Carbon dioxide and hydrogen cyanide escaped from the lithosphere into air, and were also trapped in volcanites and freezing waters (Fig. 3). The CN-radicals that now spurt out of Hartley2 nucleus could not have survived under oxygenic conditions. Consequently, Planet X atmosphere consisted CO_2 (from volcanoes), water vapor (evaporating from seas), likely nitrogen etc., but no oxygen.

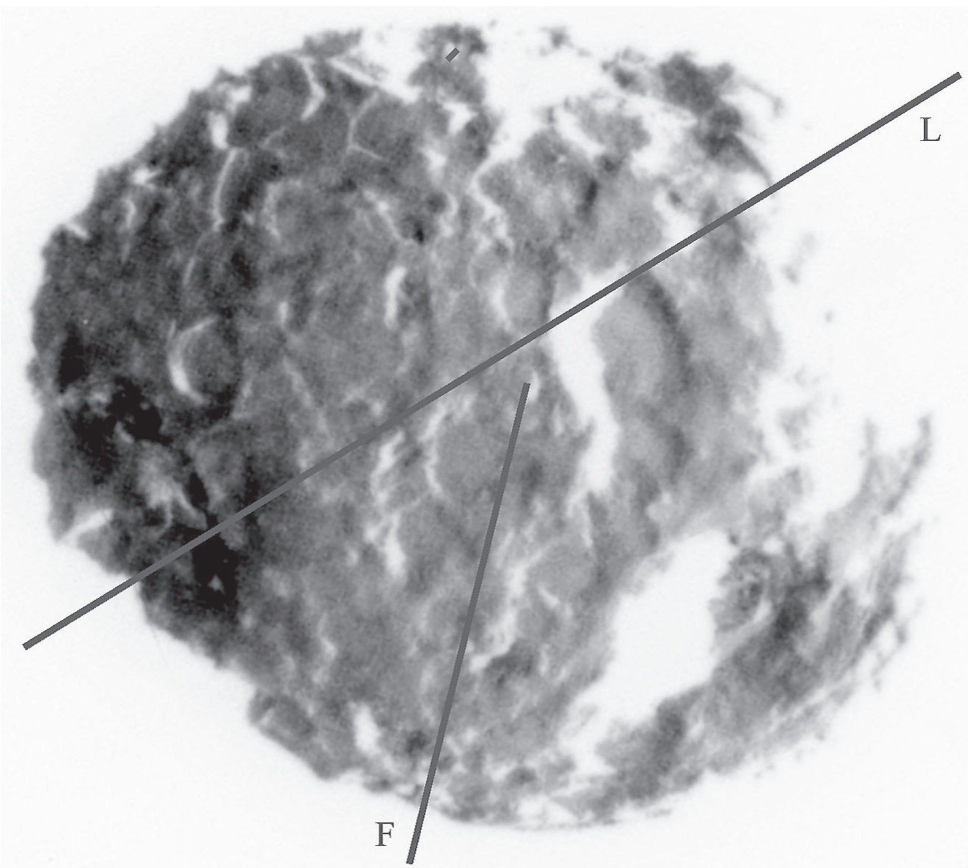

Fig. 6. Wild2 comet nucleus. Credit: STARDUST Team, JPL, NASA

Heavy cratering cannot mask primary layering (trending L) and stress fracturing (F). The attitude and intensity of layering and fracturing equal those identified in other nuclei, and on Phobos.

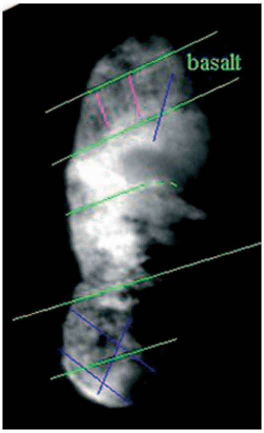

Fig. 7. Borrelly comet nucleus. Courtesy NASA/ JPL-Caltech.

The Borrelly nucleus displays fascinating geological features. We have the same primary layering (trending green) and stress fracturing (blue) as in every other image; however, topmost layers display an intense fracture pattern (pink), perpendicular to layering. Lava flows of basaltic composition fracture on cooling into columns in exactly that way. The 1000+ centigrade flow had eroded underlying strata. Eruption occurred in several pulses, all on dry land. The flows are likely topped by volcaniclastic rocks and weathering products. What an amazing geology did exist in that lost world!

Early life

The lack of oxygen in atmosphere does not exclude the possibility of life sparking in Planet X seas. Prerequisites for photosynthetic life did exist: amines could have been synthesized from HCN, together with hydrocarbons from methane and CO_2, by solar UV energy. Phosphorus was available in seawater from weathering apatite, while silica, calcium, magnesium, sulphur and metals liberated from other rock forming minerals and subsurface ore forming processes.

If life existed, oxygen was produced by photosynthesis. However, all of the oxygen was immediately removed from the ecosystem via the oxidation of water-soluble ferrous ions to insoluble ferri oxide atoms that precipitated and deposited with silica on seafloor as Banded Iron Formation (BIF). In the writer's opinion, BIF is the best indicator for early, oxygen-producing photosynthetic life on any planet, Earth and Mars included.

A BIF deposit and organogenic carbon, 4 billion years old, exist in Isua, Greenland. Planet X might have sparked and supported life older than that.

Conclusions

Only one major collision is known to have occurred within the life zone – the one that produced our Moon. Thus:

- Phobos and comet nuclei originate from outer layers of the geologically active Planet X – the Earth.
- A collider scraped either of the Earth's polar regions.
- The collision likely tilted the Earth's rotation axis.
- Asteroids and meteoroids that from time to time strike us are fragments of the Earth's crust returning home.
- Whether or not the collision extinguished early life on Earth does not matter. BIF occurrences demonstrate that life was not a once only incident but sparked up several times before stabilization c. 2 billion years ago.

Asteroids provide a rare window for a glimpse upon Hadean Earth, older than 4 billion years.

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