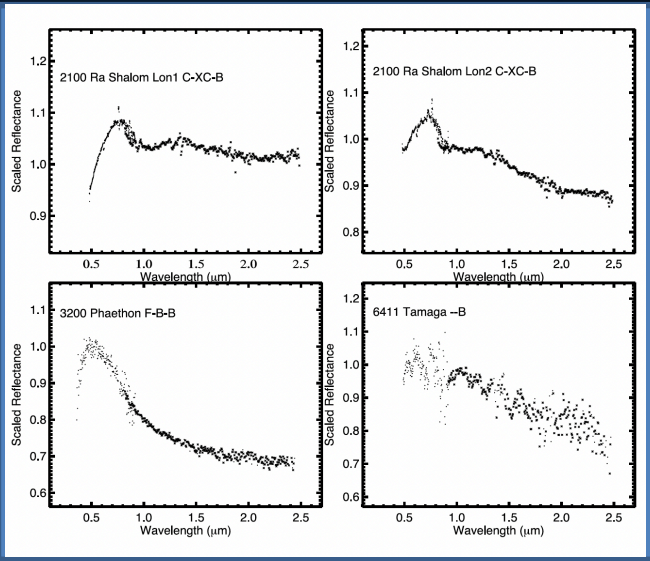
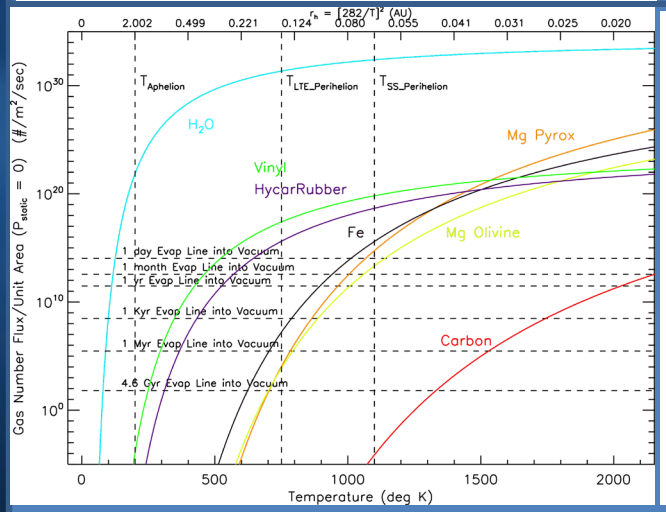
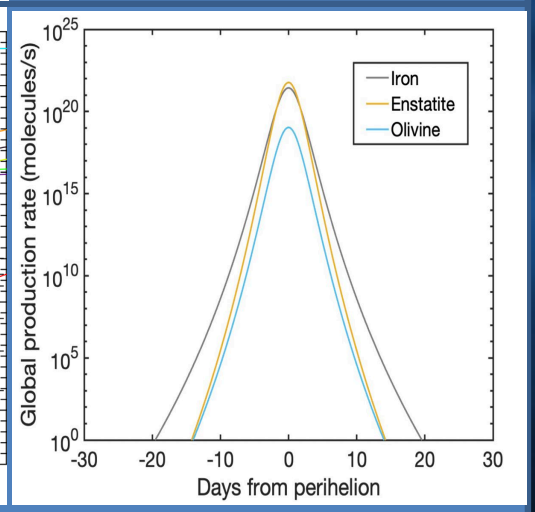
JOHNS HOPKINS
APPLIED PHYSICS LABORATORY

# Thermal Alteration and Differential Sublimation Can Create Asteroid Phaethon's "Rock Comet" Activity & Extremely Blue Color




Of the ~20 rare blue asteroids known, 3200 Phaethon is the bluest (lower left). The average asteroid, of the ~200,000 known, is reddish to neutral. Phaethon is also the asteroid with the closest known approach distance to the Sun, and thus its surface gets extremely hot (up to ~1100K).




Vapor pressure curves for materials likely inside Phaethon show that its extreme heating at perihelion should remove all Fe, organics, and pyroxene in its surface layers, leaving behind a clean blue residual.

**The same thermal effects that would create the "rock comet" behavior of 3200 Phaethon would also greatly bluen its surface, via preferential thermal alteration and sublimative removal of very red surface Fe and refractory organics.**

- 3200 Phaethon is a "comet-asteroid transition object" [Jewitt and Li, 2010]. It behaves like an asteroid for most of its orbit, but near perihelion (0.165 AU from the sun) its dayside temperatures are hot enough to vaporize rock.
- Gases produced from the evaporating rock are released in a manner similar to the sublimation of water ice seen for more typical comets when they come ~3 AU to the Sun.
  - Loss rate of $Q_{gas}$ ~ $10^{22}$ mol/sec at perihelion
- The loss of nanophase iron & refractory organics explains extremely blue surface color compared to other asteroids.
- These predictions are testable by surveying other objects on Phaethon-like small perihelion orbits, and by in situ measurements from the upcoming DESTINY+ mission to Phaethon by JAXA.

**Lisse & Steckloff (2022) *Icarus* 381, 114995**