

The parallel grooves of Phobos

*New evidence from
HRSC Mars Express*

John Murray,



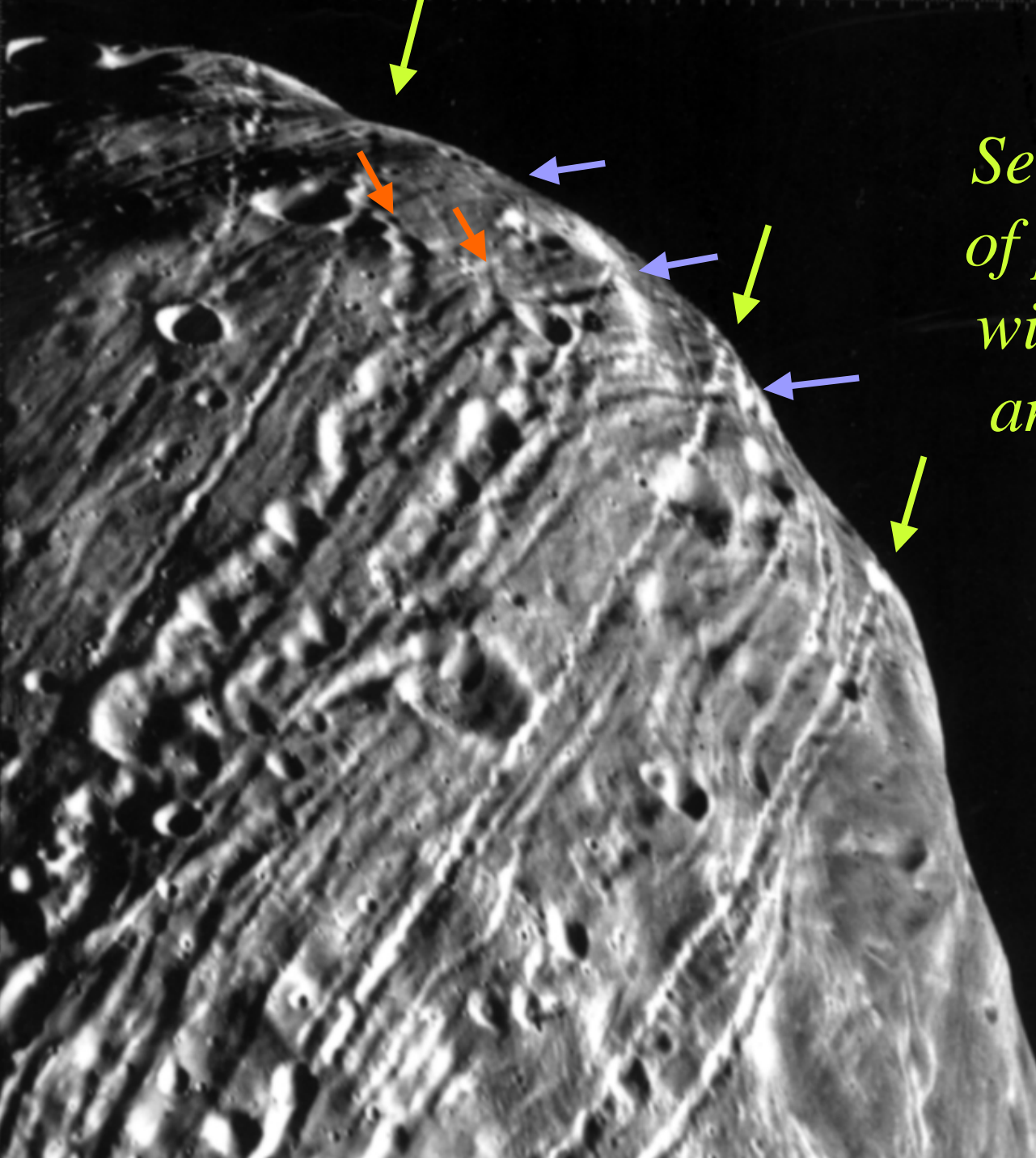
Jan-Peter Muller,



Gerhard Neukum

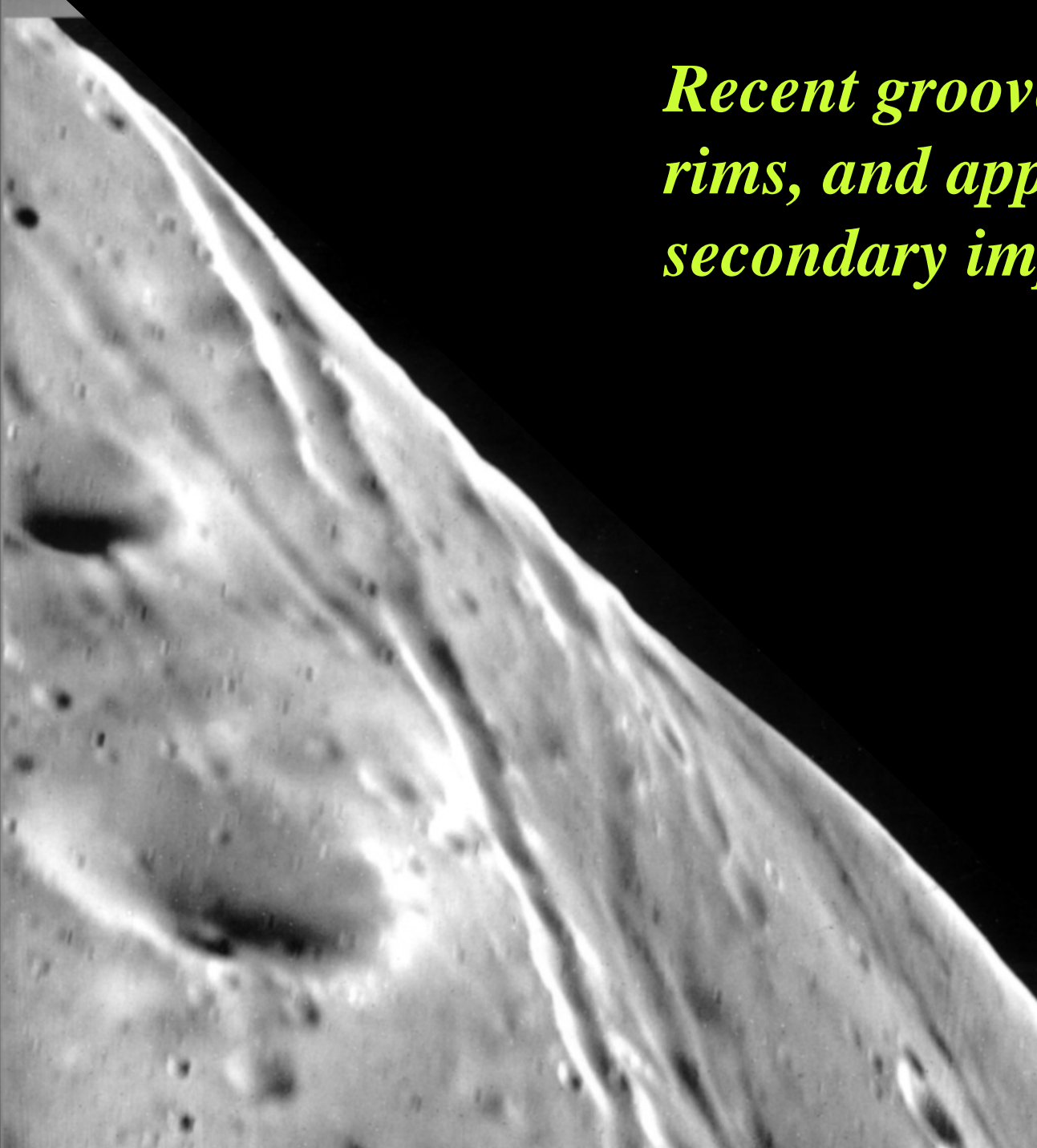
& the Mars Express HRSC Team

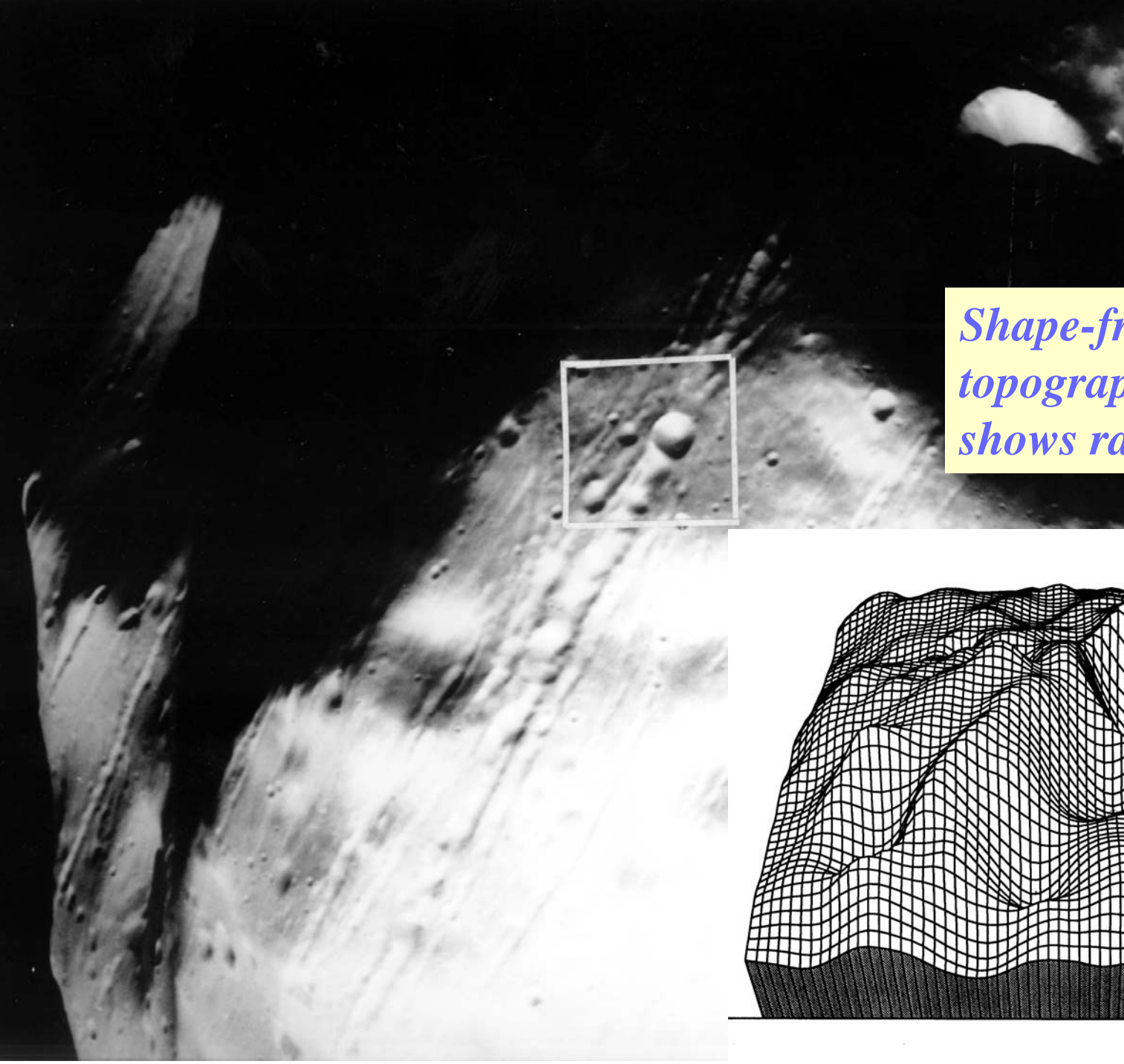




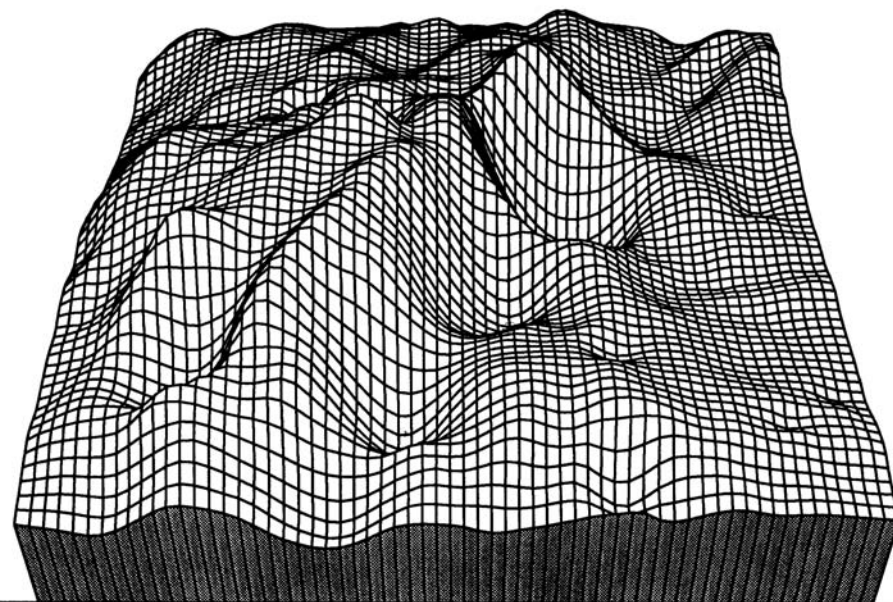
*Several “families”
of parallel grooves
with different ages
and morphologies*

*Recent grooves have raised
rims, and appear similar to
secondary impact craters*

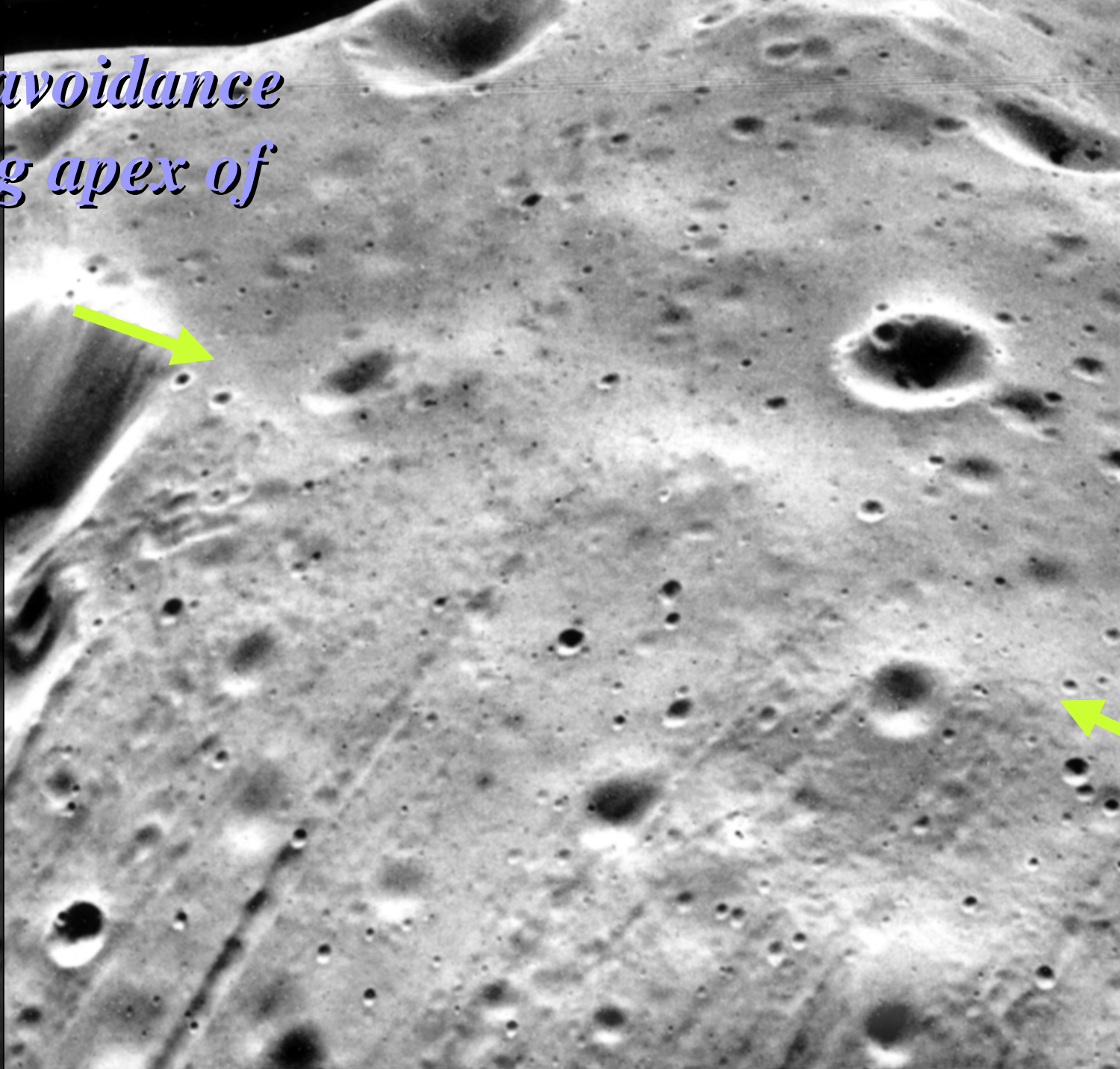




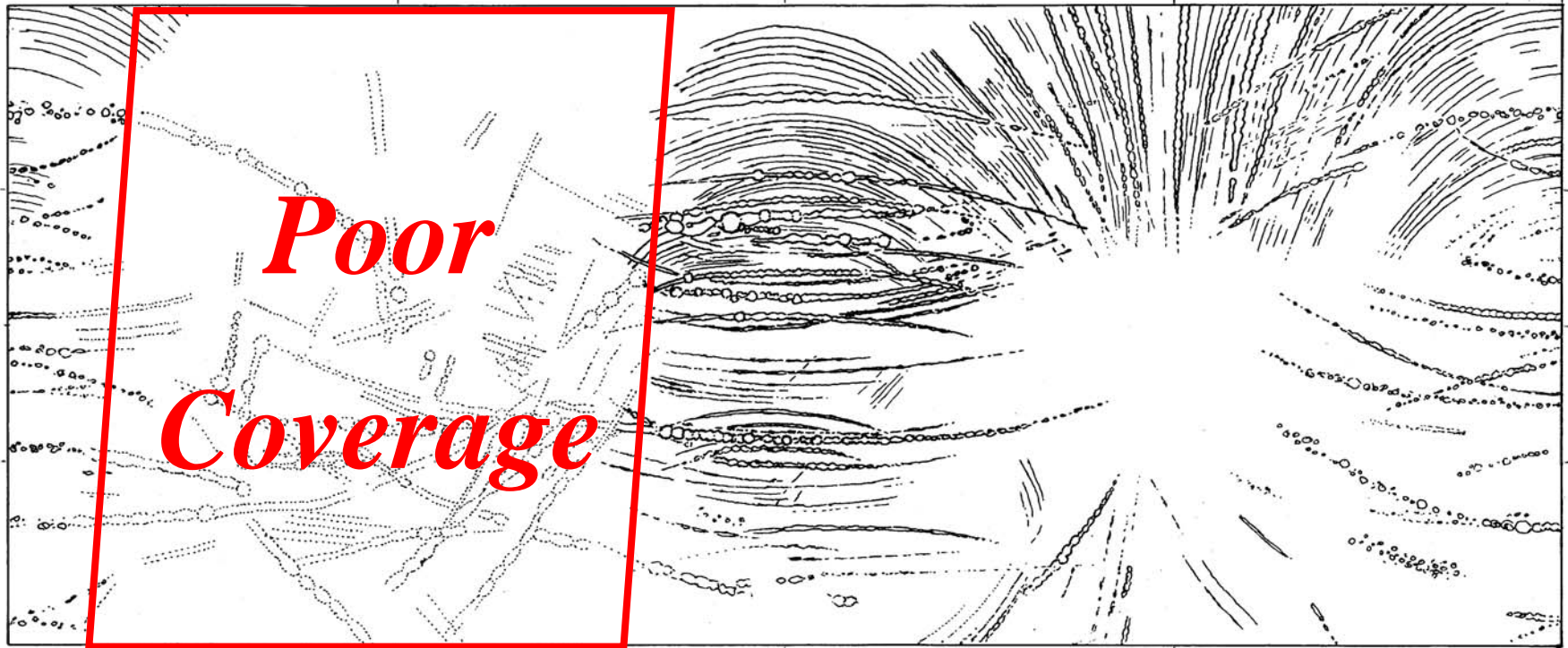
*Shape-from-shading
topography also
shows raised rims*



*Zone of avoidance
at trailing apex of
Phobos*



Pre-Mars Express map of Phobos' grooves



**Leading
edge**

**Sub-Mars
meridian**

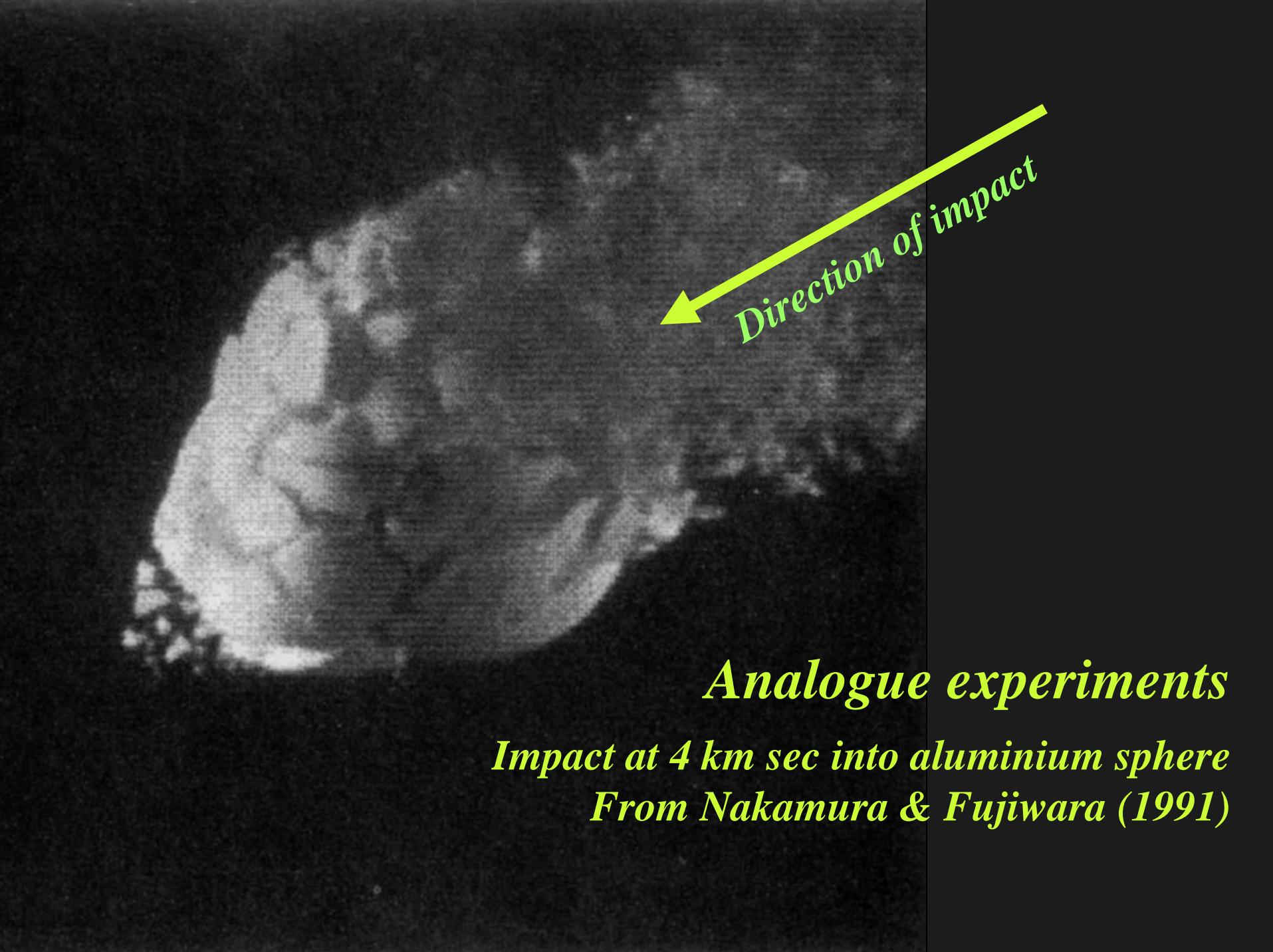
**Trailing
edge**

Stickney crater

*Deeply entrenched in
Phobos mythology as
fundamental to groove
origin, either as:*

- 1. Cause of fracture system*
- 2. Source of secondary craters*



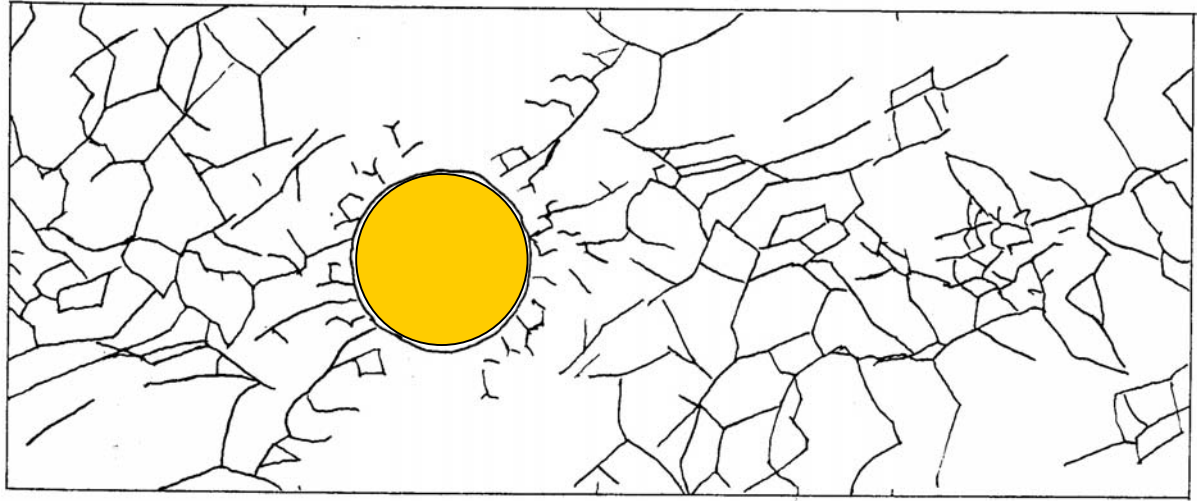


Direction of impact

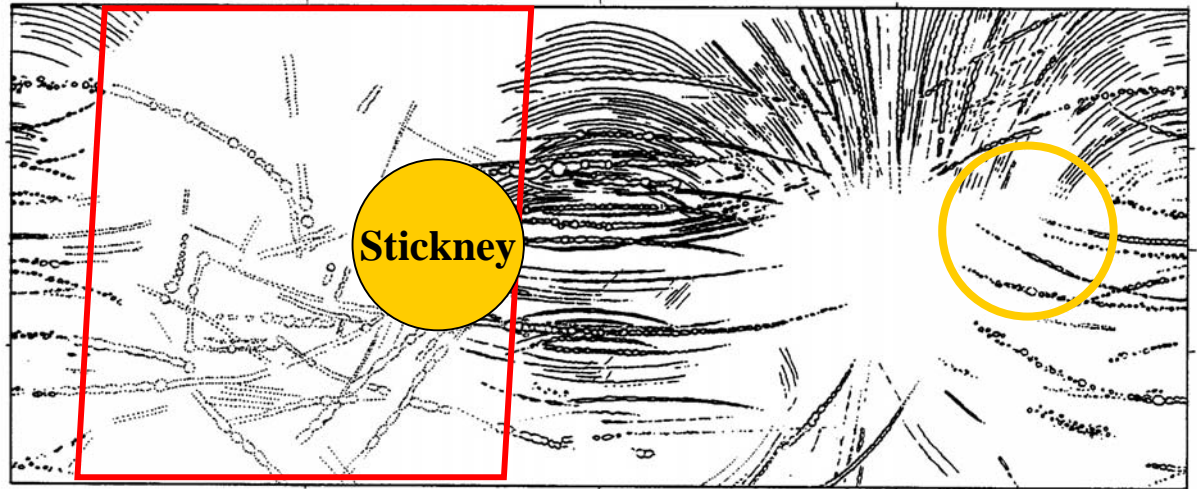
Analogue experiments

*Impact at 4 km sec into aluminium sphere
From Nakamura & Fujiwara (1991)*

Fracturing Model

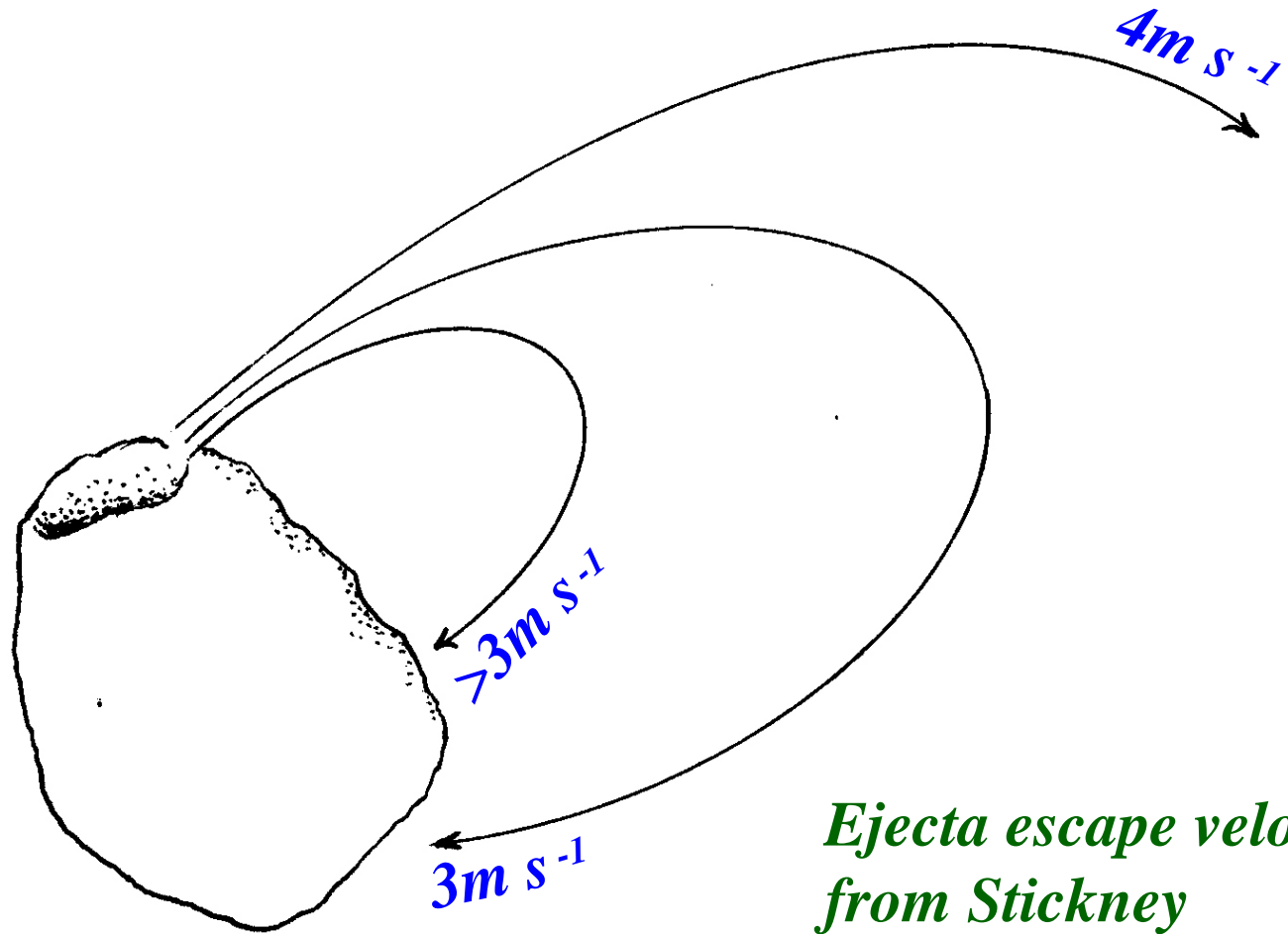


Phobos



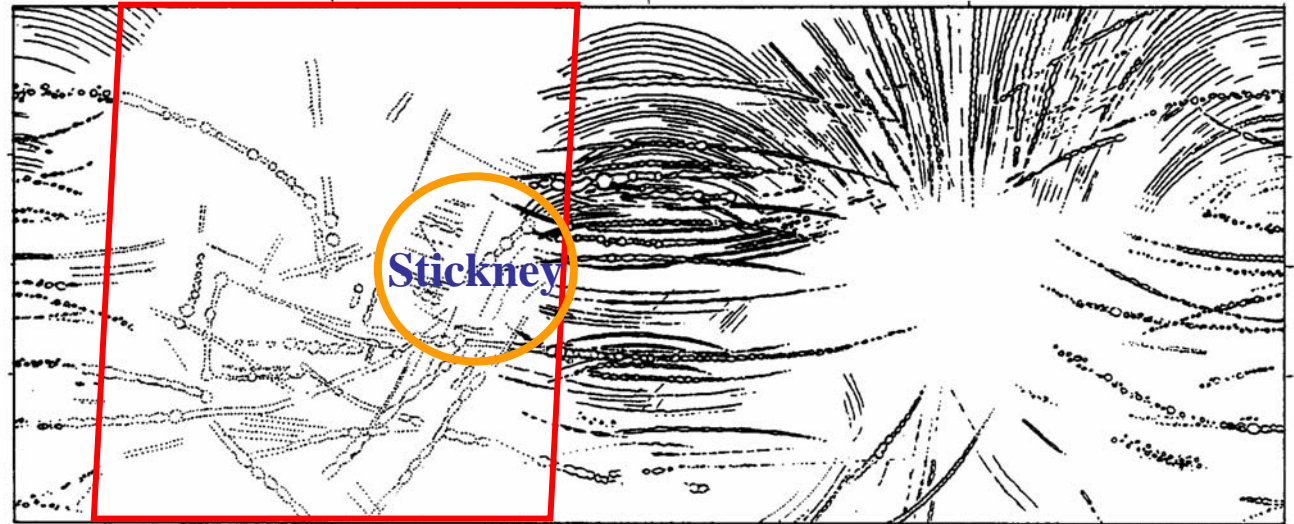
*Secondary craters from
Stickney?*



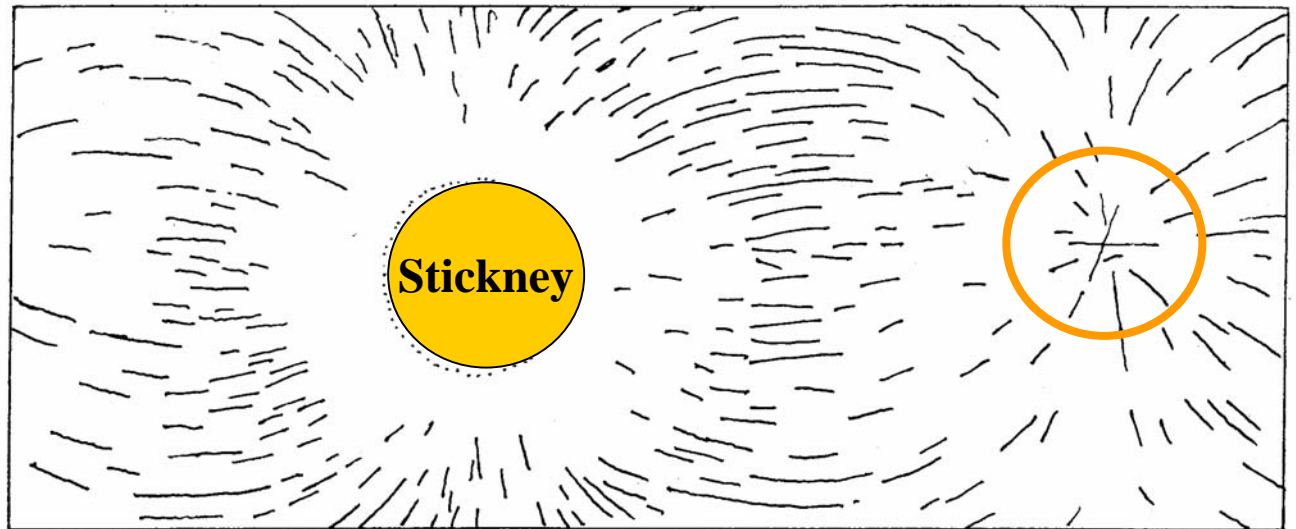


*Ejecta escape velocity
from Stickney
= $\sim 3\text{ m s}^{-1}$*

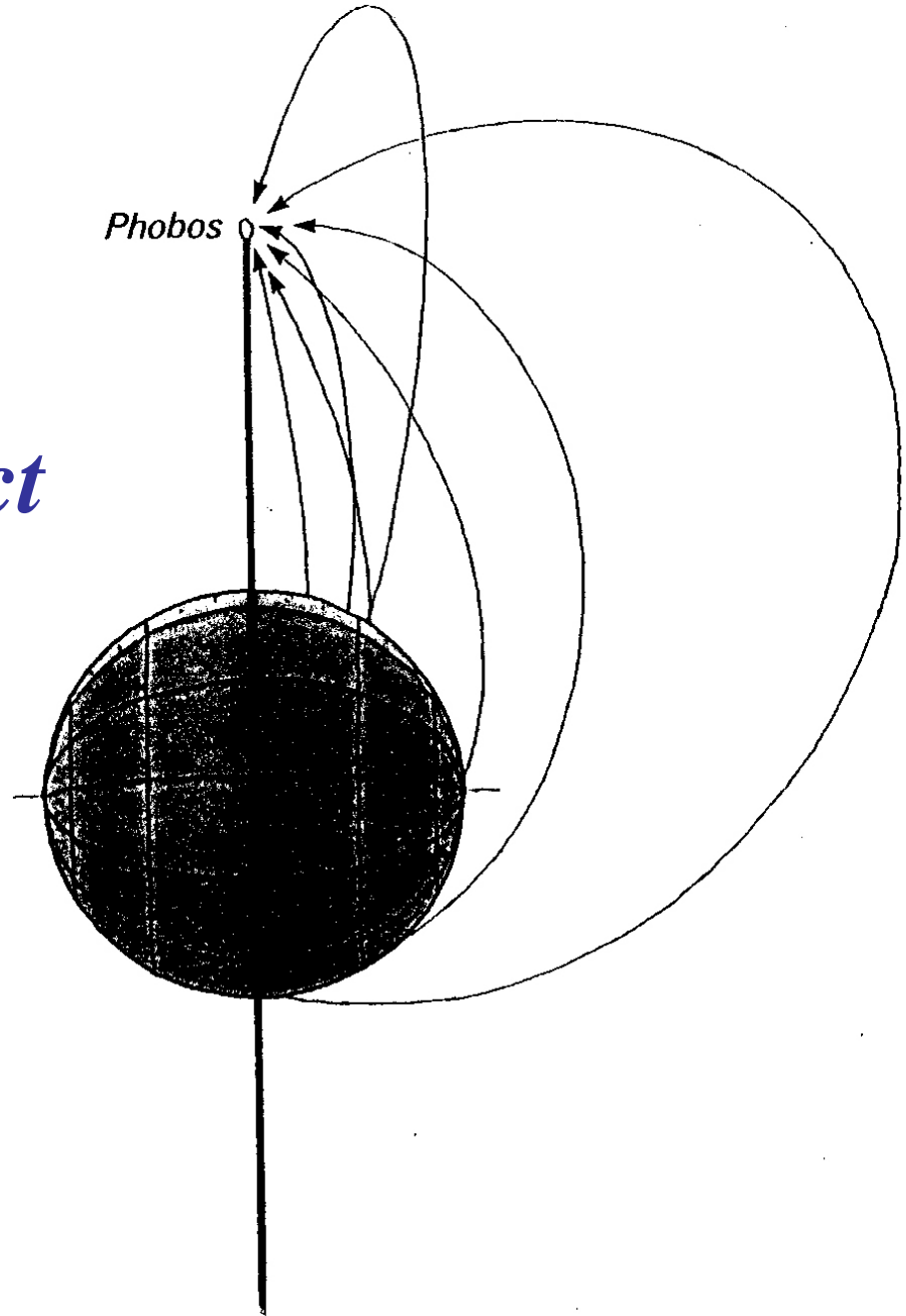
Phobos

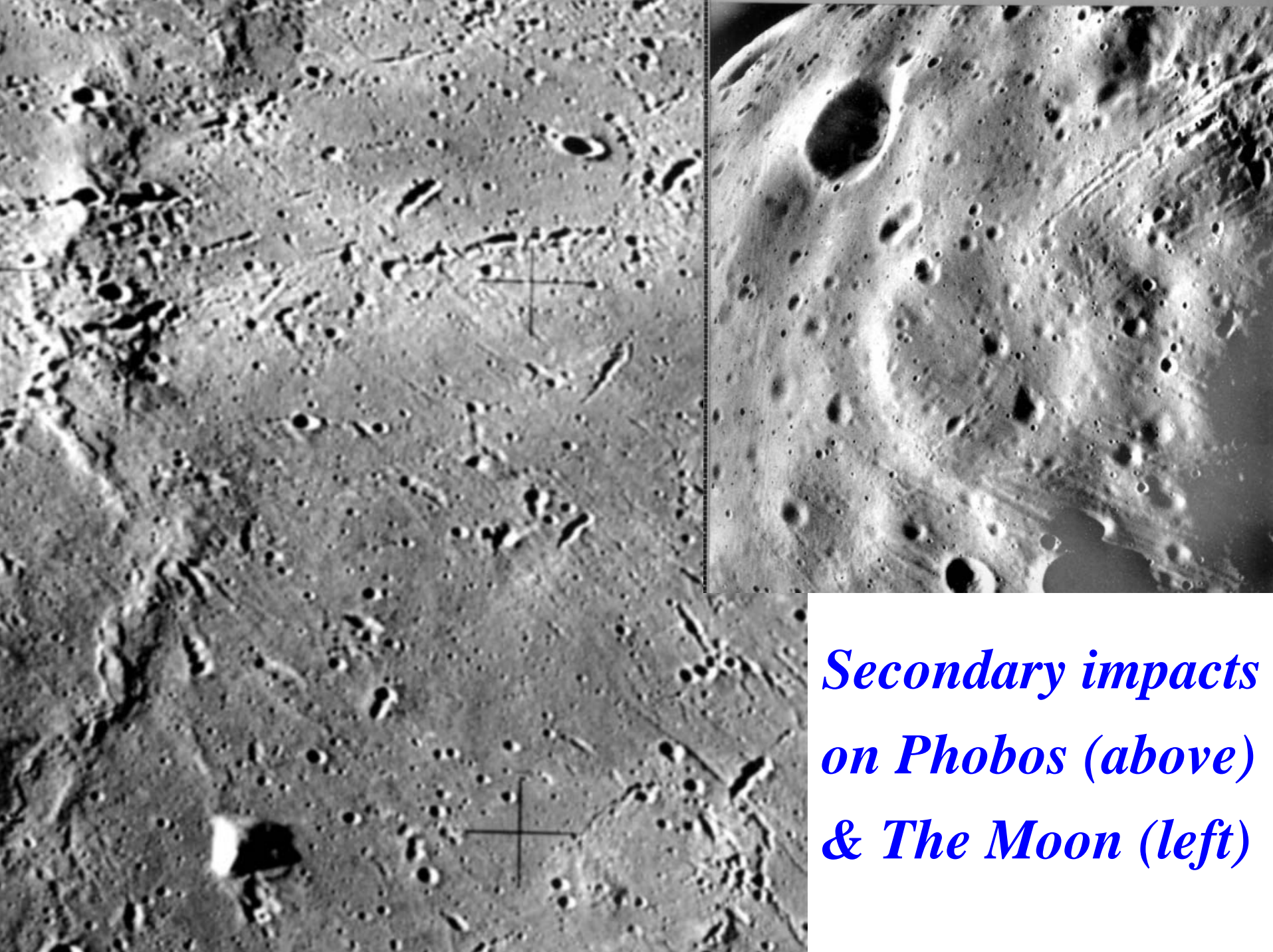


Stickney secondary model

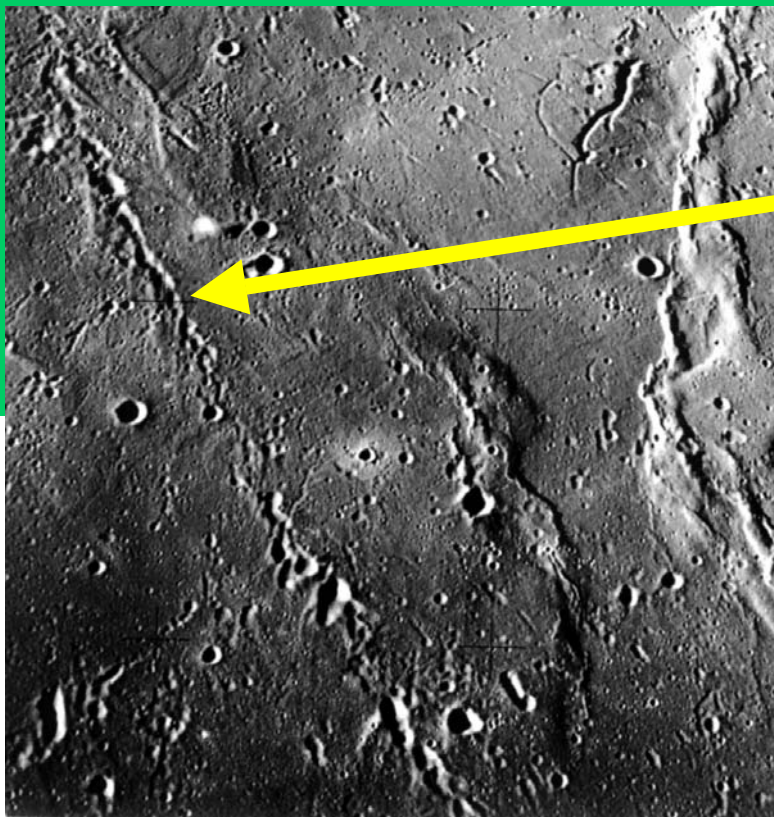


*Secondary impact
chains from
Mars craters*





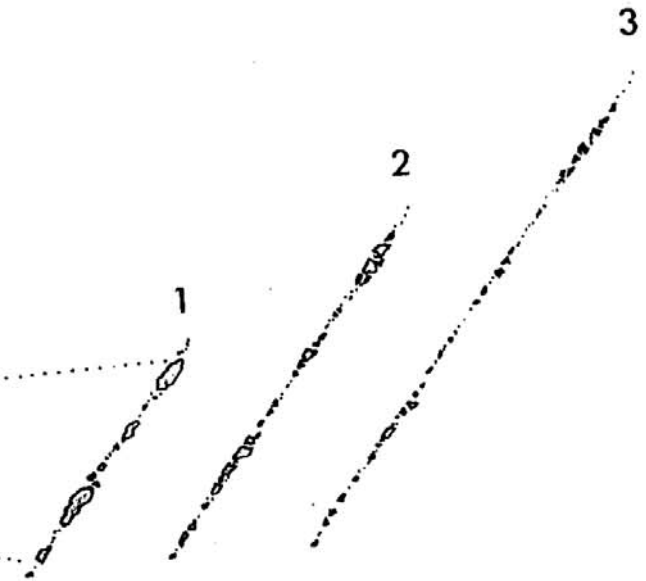
*Secondary impacts
on Phobos (above)
& The Moon (left)*



*Lunar secondary
Crater chain*

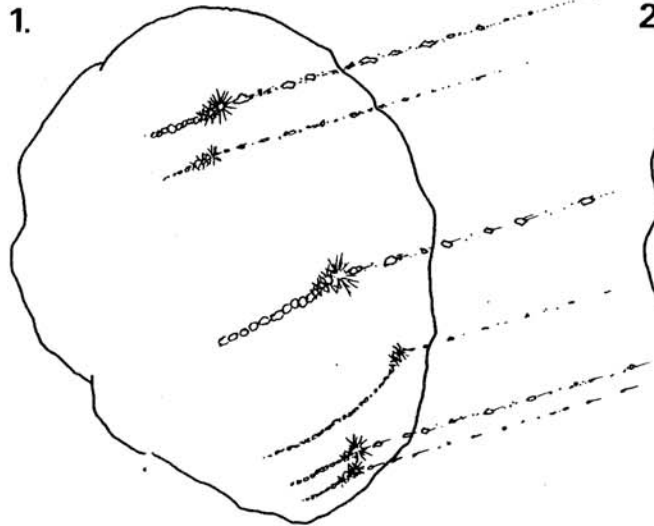


**Primary
impact**

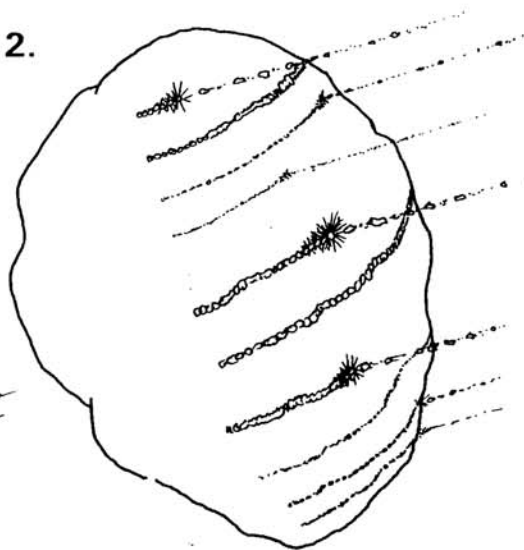


Ejecta strings

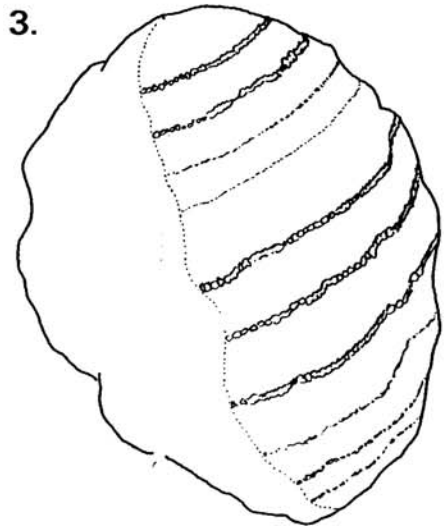
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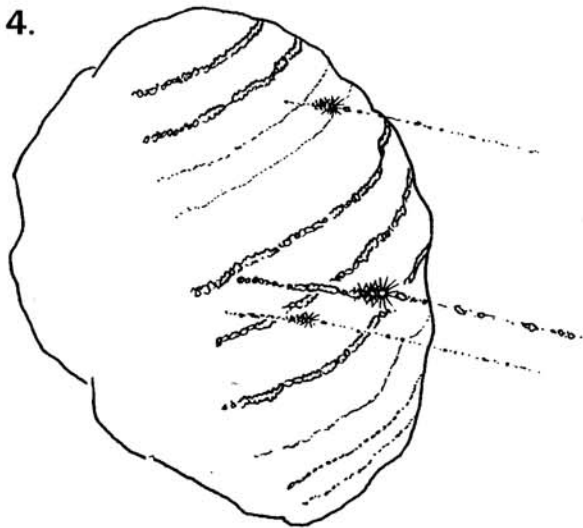
2.



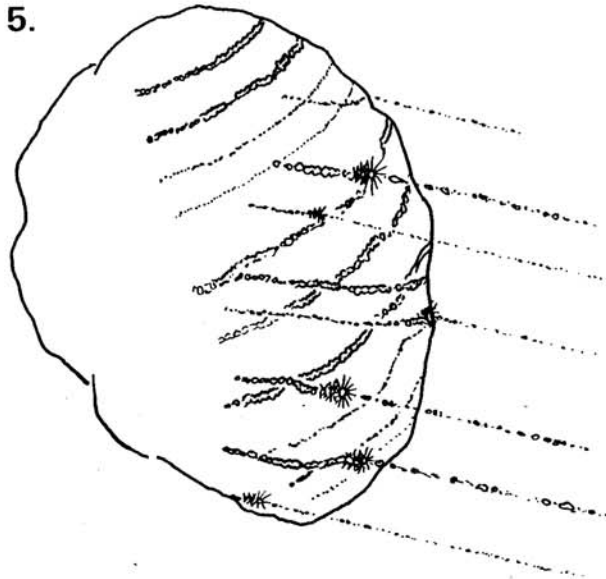
3.



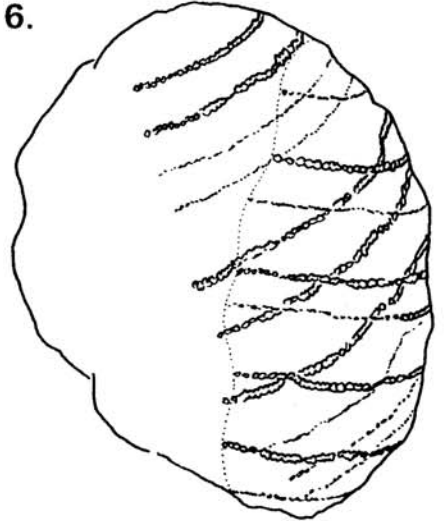
4.

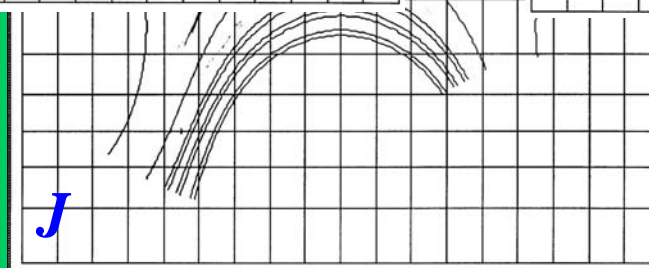
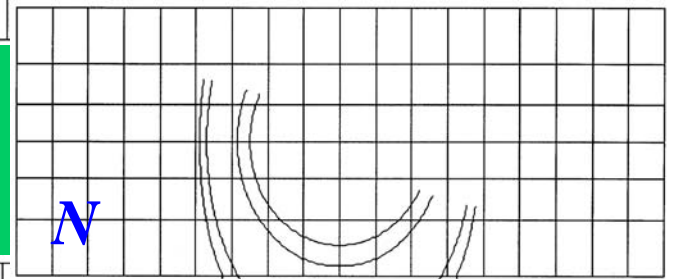
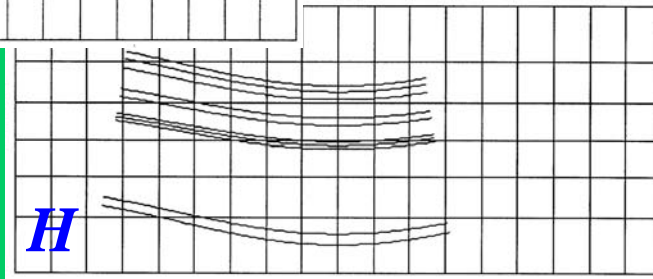
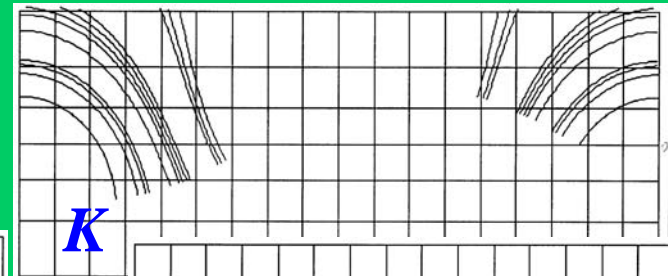
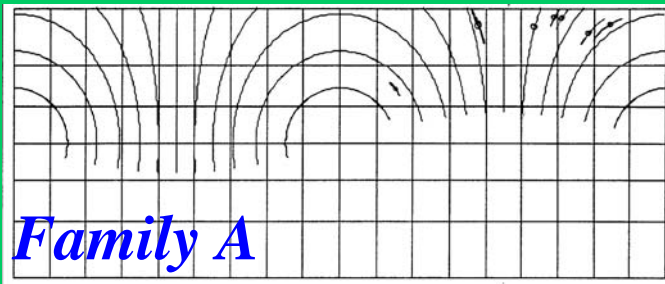


5.



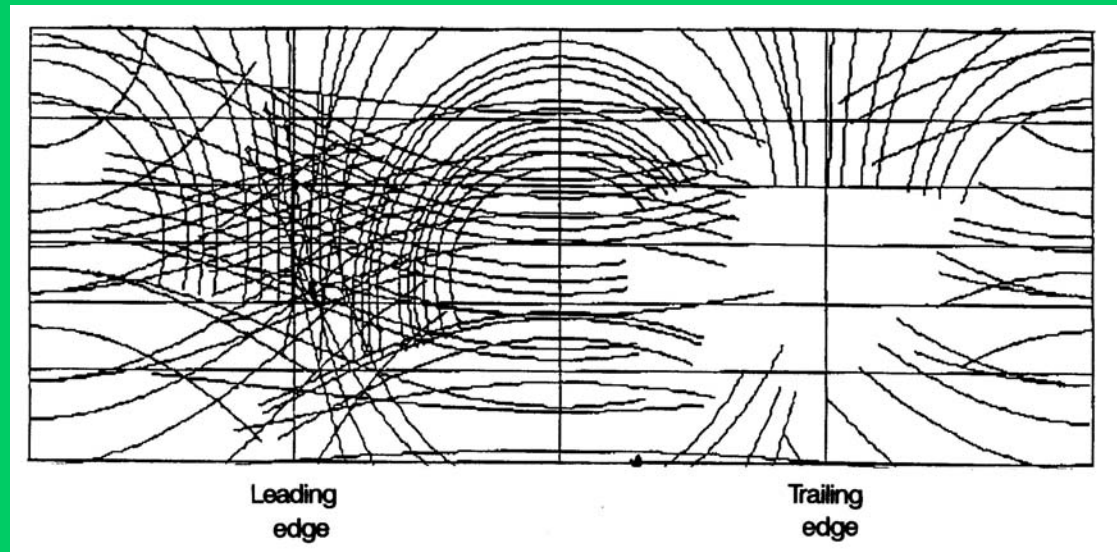
6.

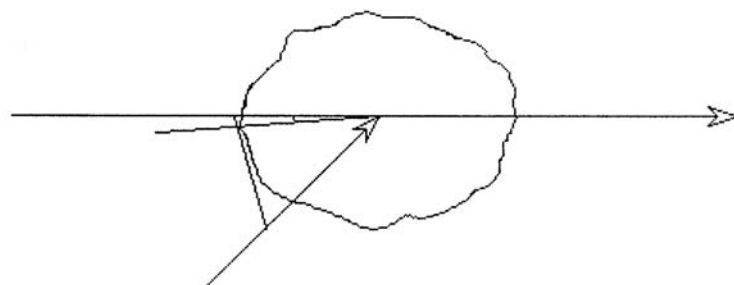
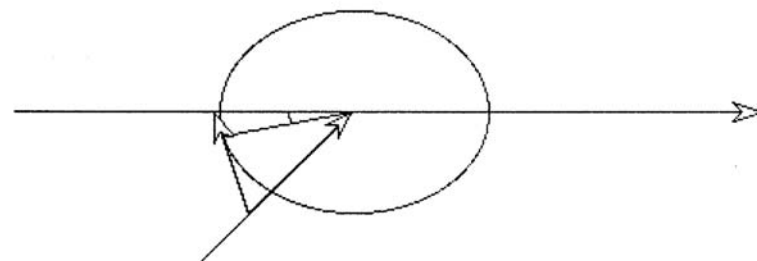
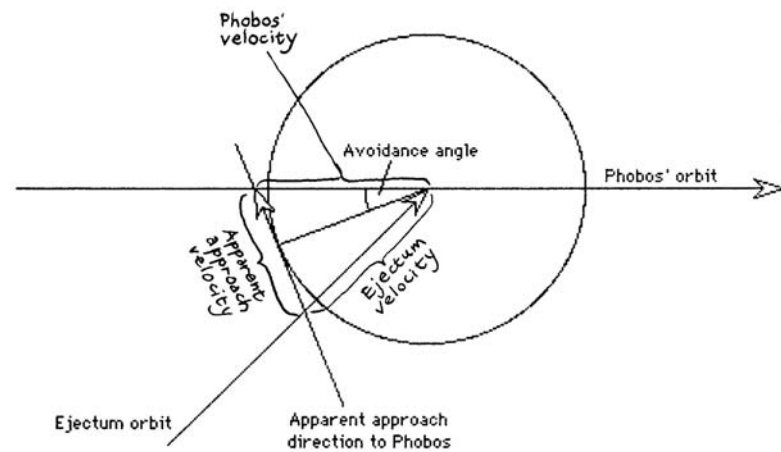
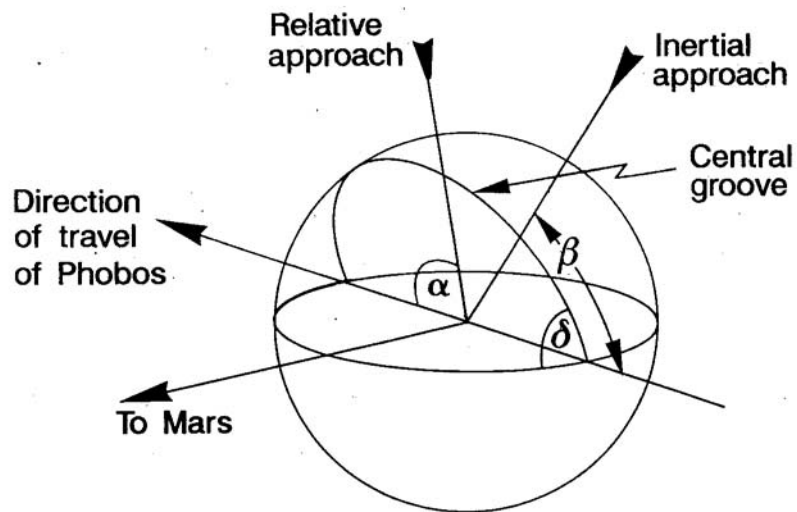
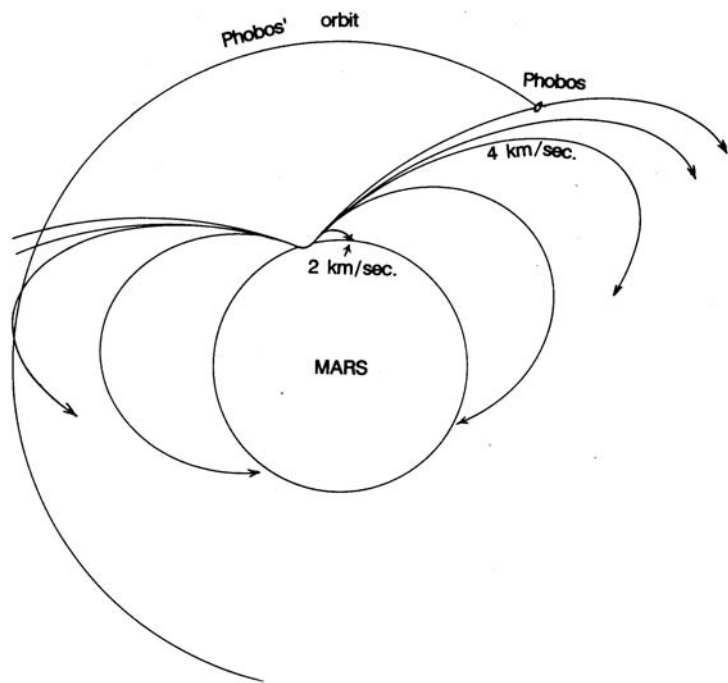




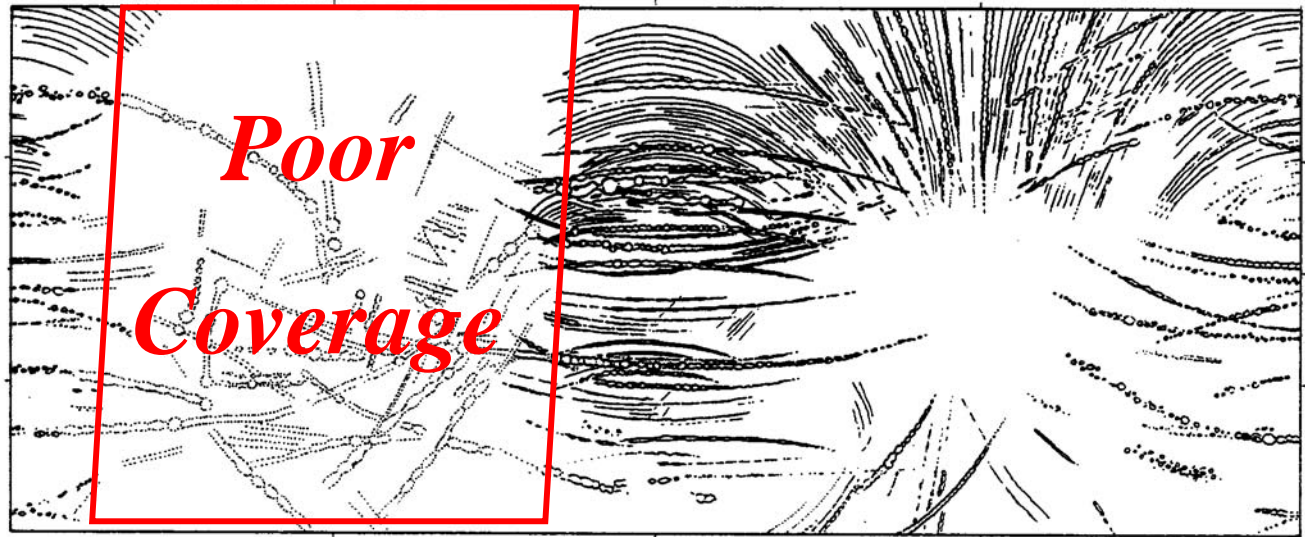
Many families combined ▼

Mars secondary impact model ➔

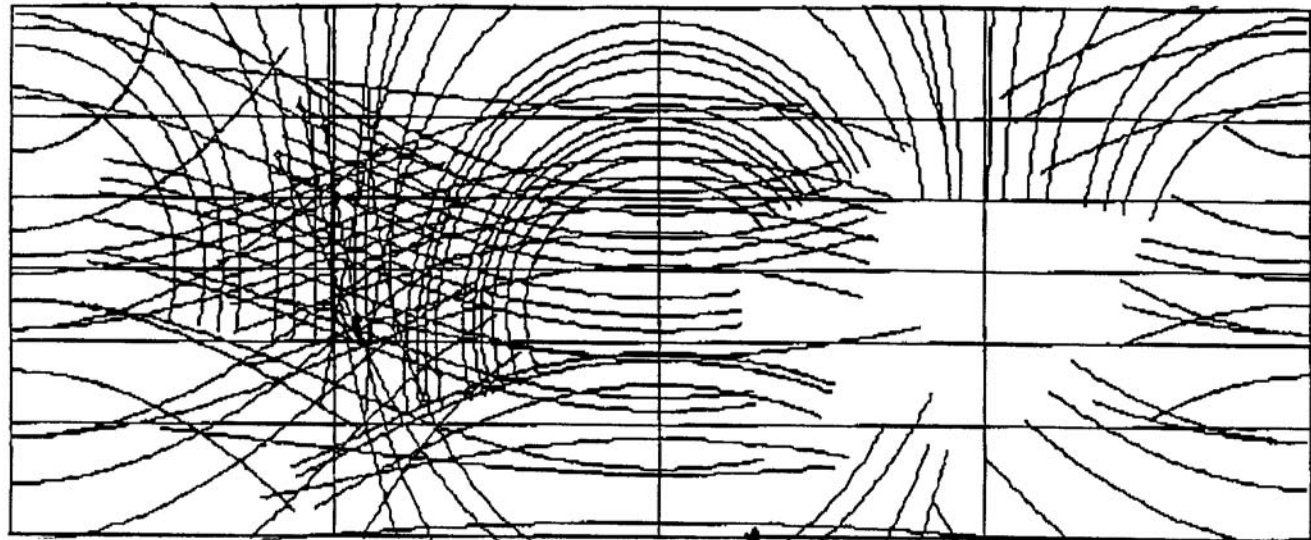




Phobos



*Mars
Secondaries
model*



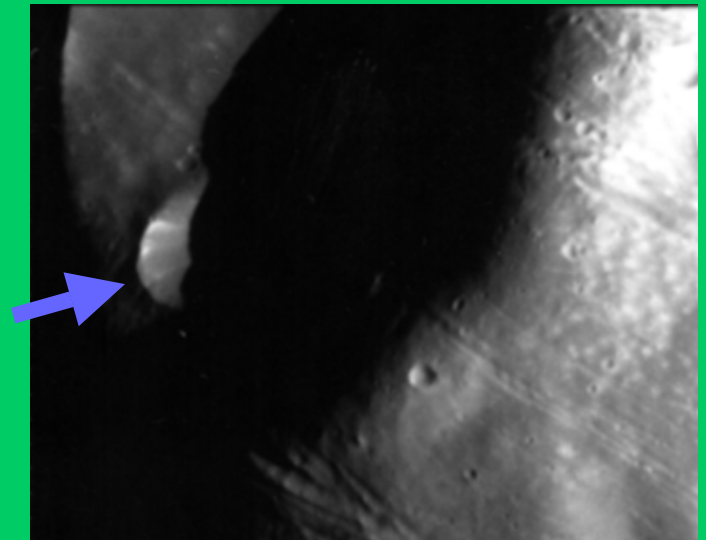


*Groove topography:
raised rims?
impact profiles?*

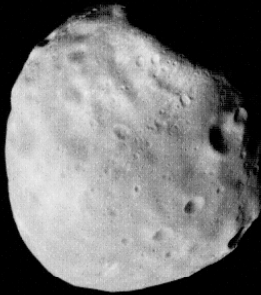
***Further
evidence?***



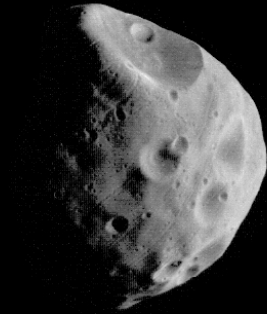
*Groove ages:
much later
than Stickney?*



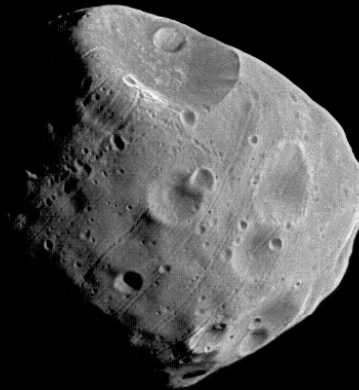
...enter Mars Express: six passes so far, more planned



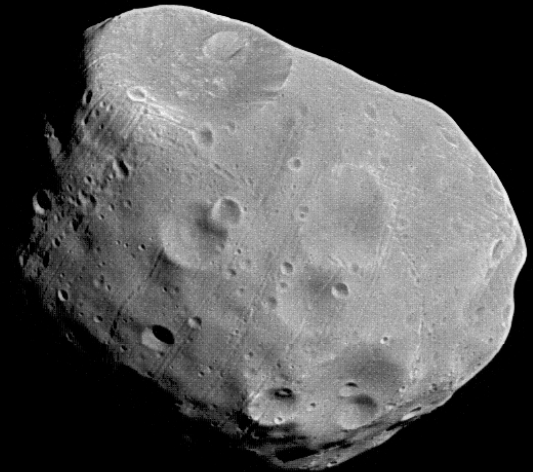
Orbit 413 (HRSC)
75.4 m/pix



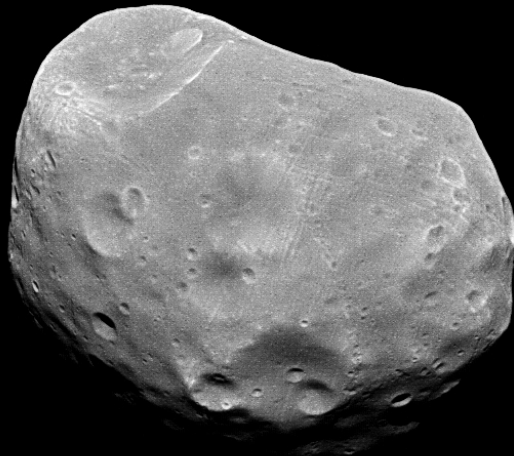
Orbit 649 (HRSC)
73.4 m/pix



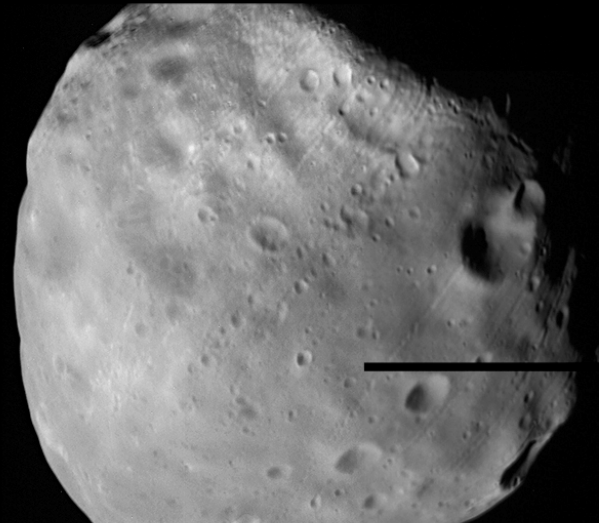
Orbit 682 (HRSC)
58.7 m/pix



Orbit 715 (HRSC)
48.4 m/pix

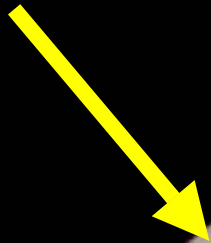


Orbit 748 (HRSC)
49.7 m/pix

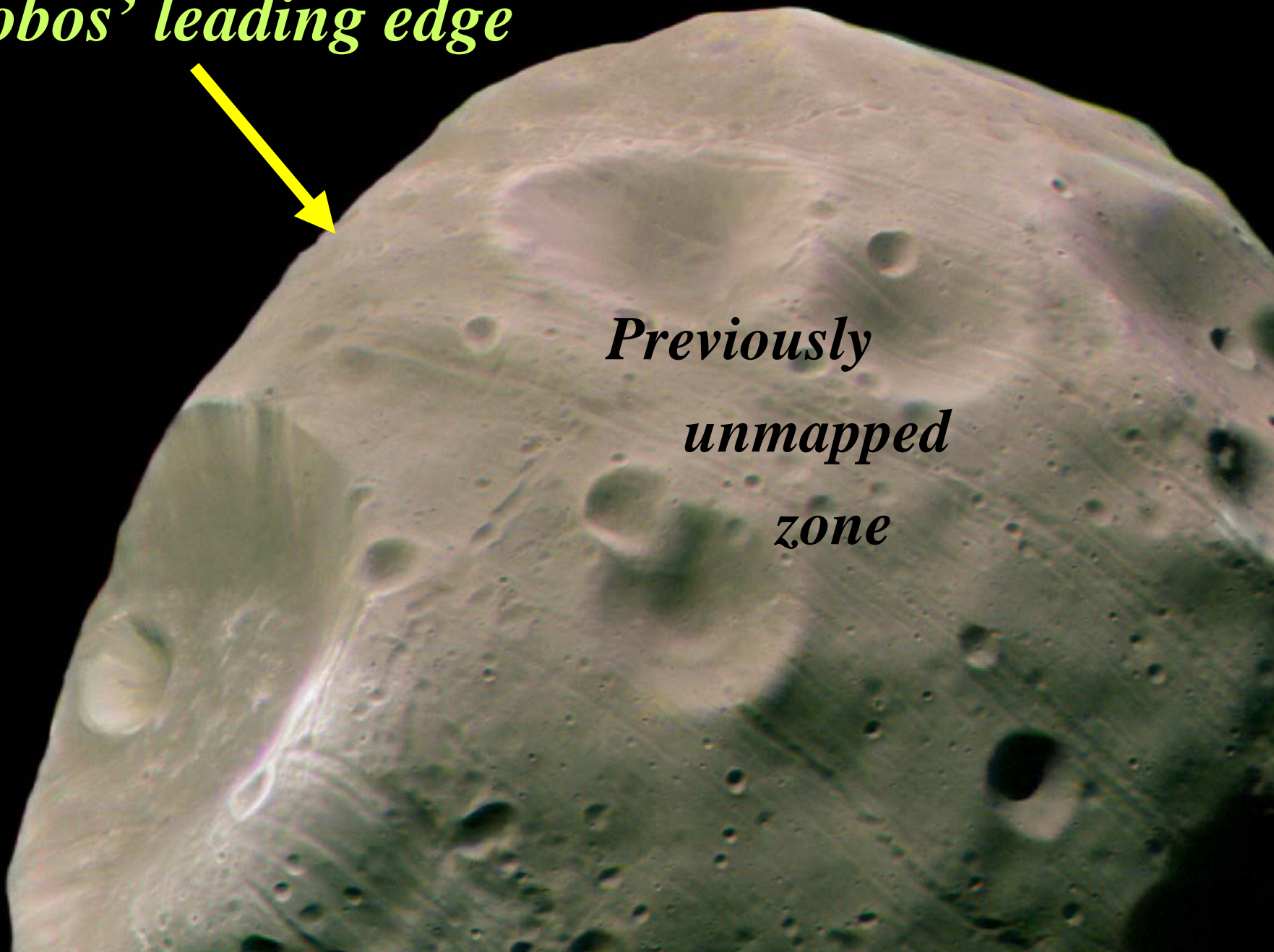


Orbit 413 (SRC)
34.6 m/pix

Phobos' leading edge



*Previously
unmapped
zone*



*Same picture at full resolution,
contrast enhanced*



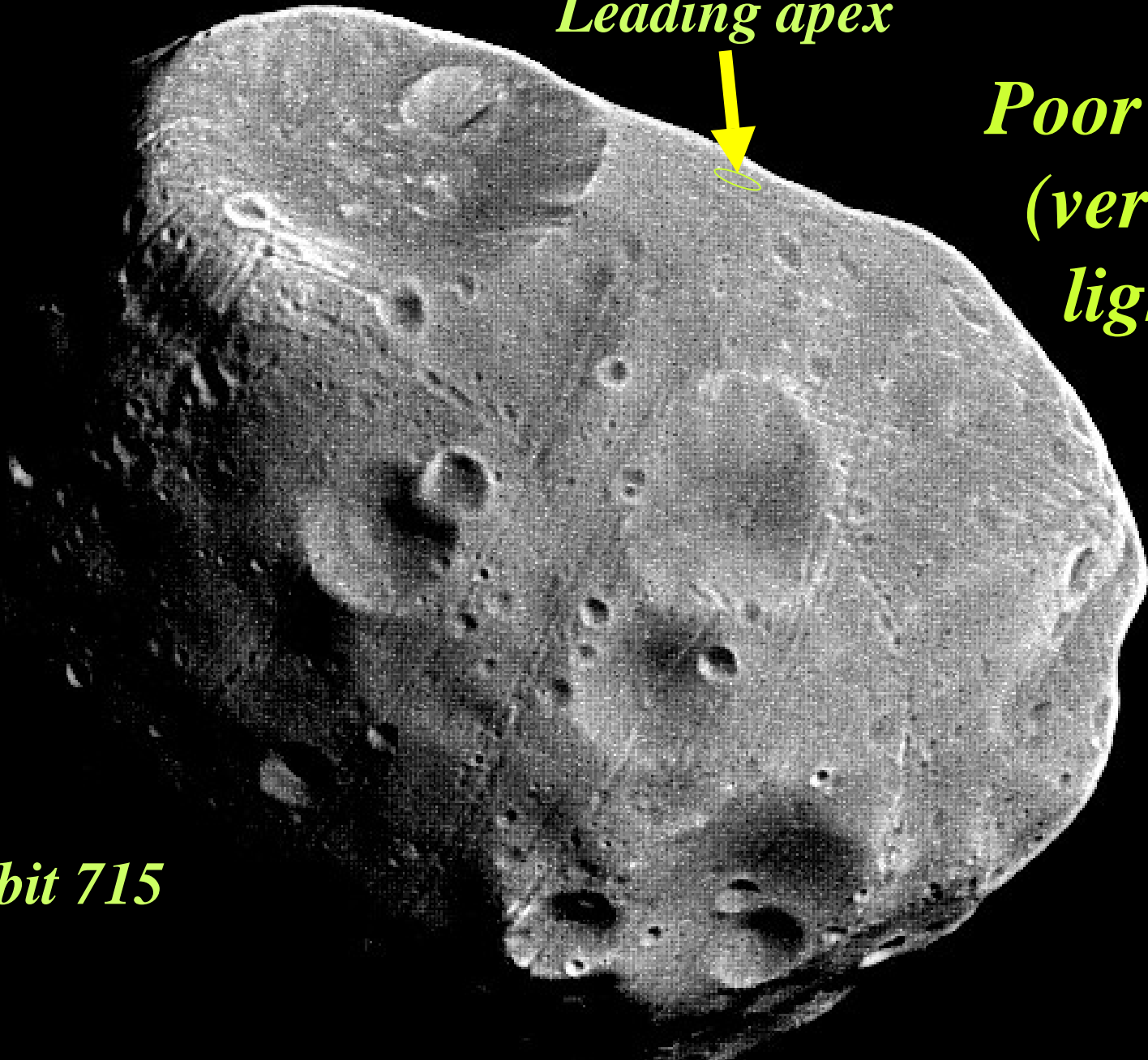
*Stickney
Crater*

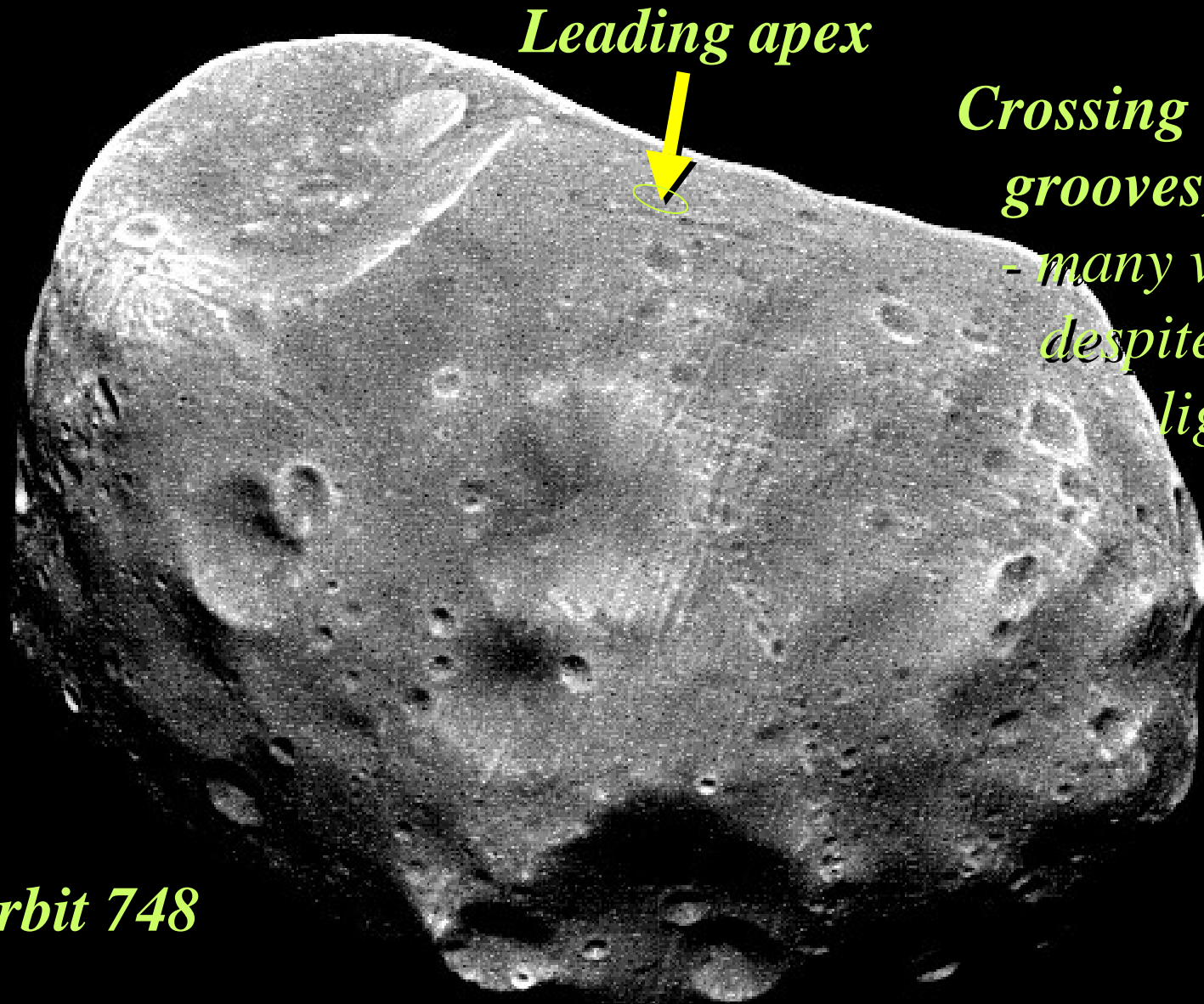
Leading apex



*Poor
(vertical)
lighting*

Orbit 715



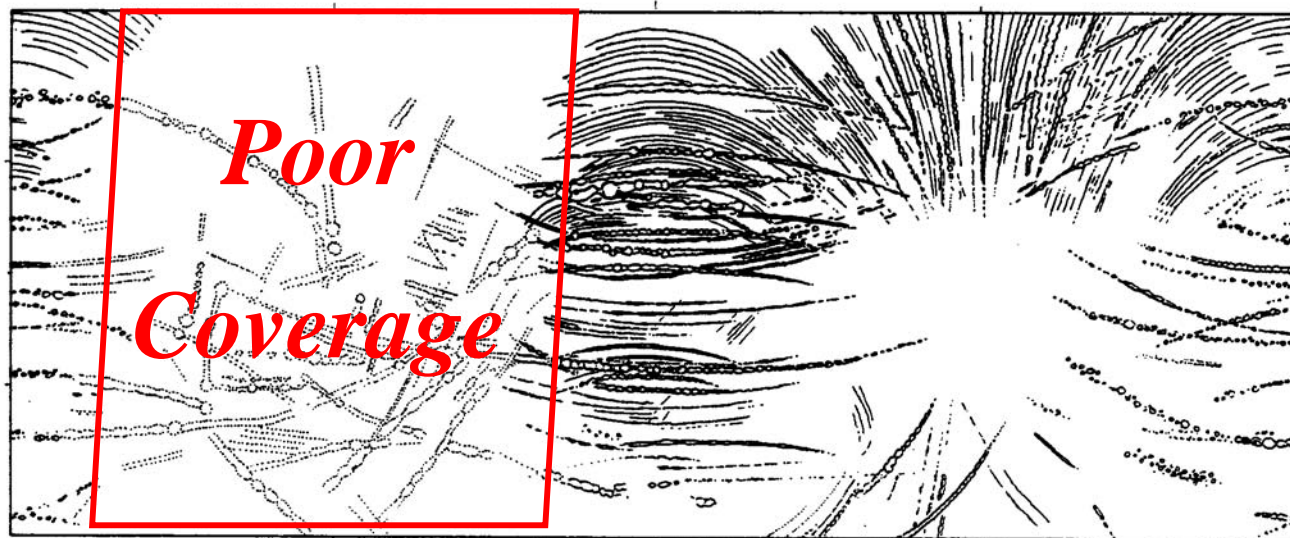


Leading apex

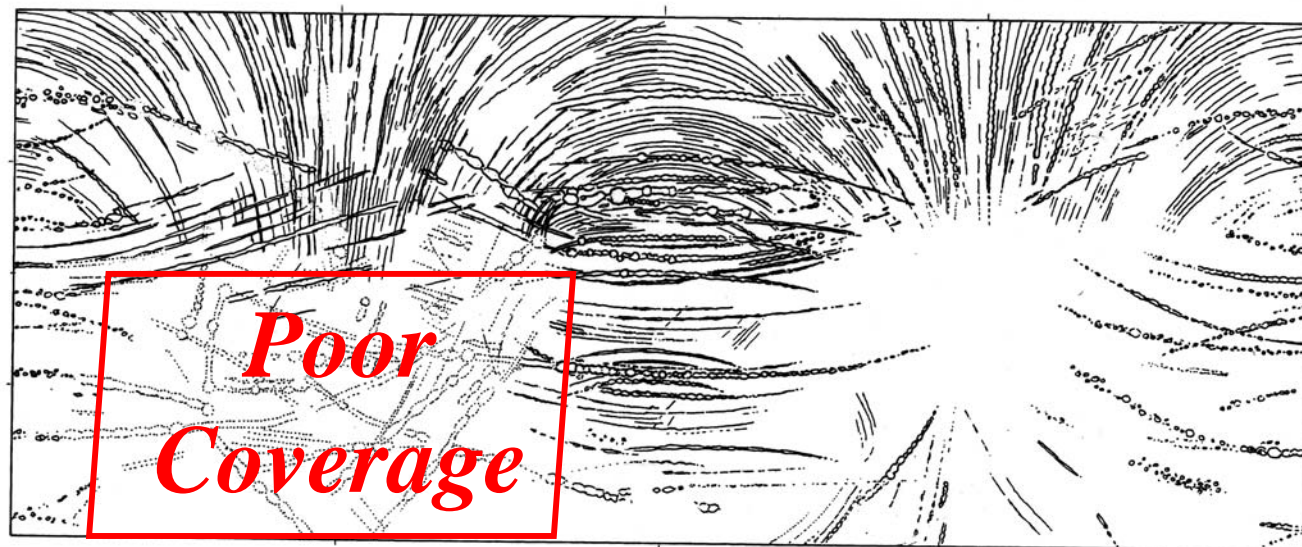
*Crossing
grooves,
- many visible
despite poor
lighting*

Orbit 748

*Pre- Mars
Express*



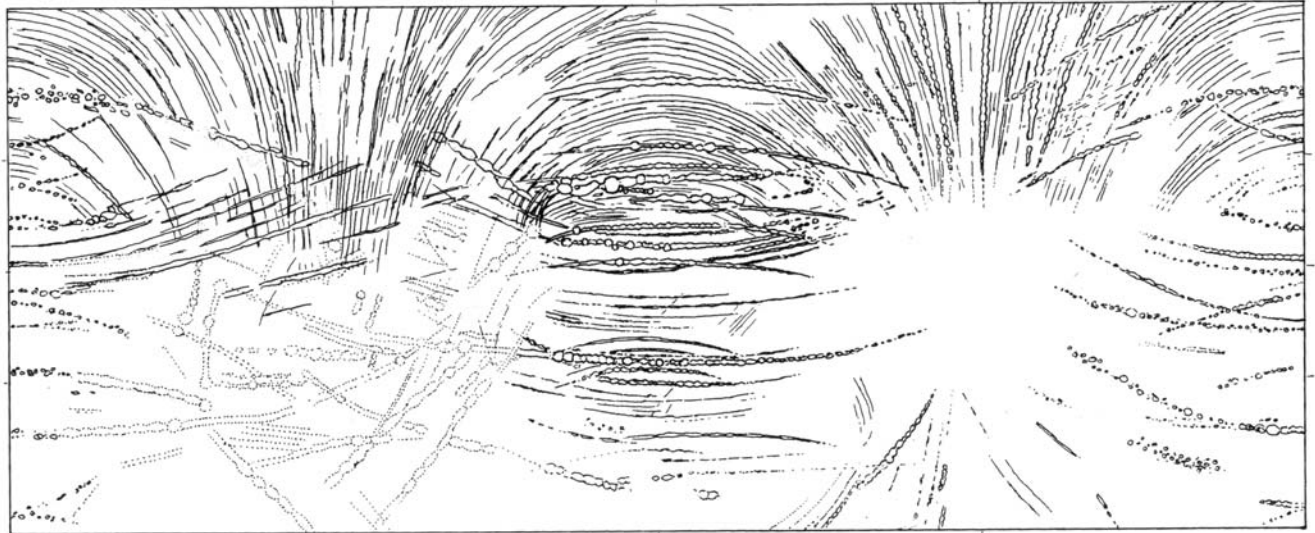
*With Mars
Express
coverage*



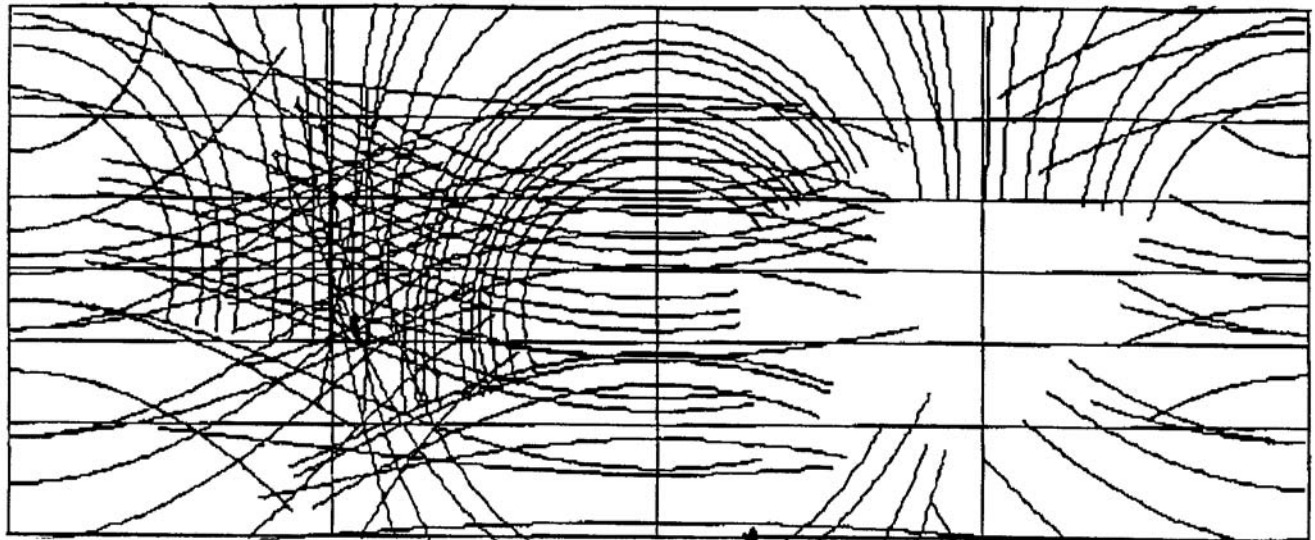
*Leading
edge*

*Trailing
edge*

Phobos



***Mars
Secondaries
model***



Leading
edge

Trailing
edge

A large, irregularly shaped rock, possibly a meteorite, is shown against a black background. The rock has a light-colored, pitted surface with numerous small, dark spots and a larger, darker, more textured base. The text "THE END" is overlaid in the center in a blue, serif font.

THE END