Potential Landing Site Targets for a Complementary US Venus Flagship Mission

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And the Venus Flagship Mission Study Team

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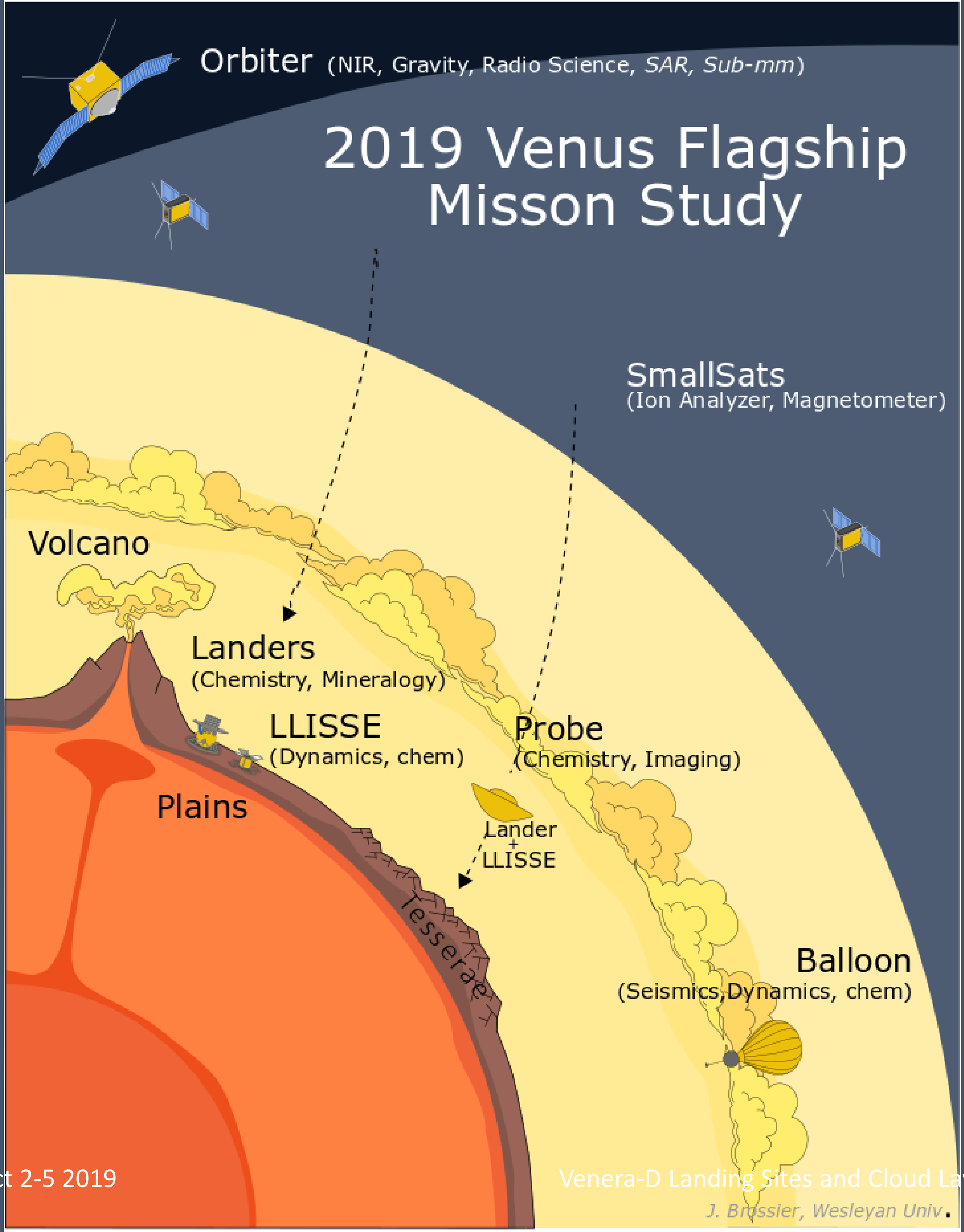
Venus Flagship Mission Concept Science Team

Name	Institution	Expertise
Sushil Atreya	Univ. of Michigan	Interior-surface-atmosphere interaction
Patricia Beauchamp	JPL-Caltech	Technology, instrumentation, Chemistry
Penelope Boston	Ames Research Center	Astrobiology
Mark Bullock	Science & Technology Corp	Chemistry of Atmospheres and Surfaces
Shannon Curry	U.C. Berkeley	Solar wind interactions with Venus
Martha Gilmore	Wesleyan. University	Surface processes, spectroscopy
Robbie Herrick	Univ. of Alaska	Geology and Geophysics
Jennifer Jackson	Caltech	Mineral Physics
Stephen Kane	U.C. Riverside	Exoplanet Science
Alison Santos	GRC	Petrology
David Stevenson	Caltech	Geophysics
Colin Wilson	Oxford University	Atmospheric Physics
Janet Luhmann	UC Berkeley	Venus escape processes
Robert Lillis	UC Berkeley	Modeling of plasma and magnetic processes
Joshua Knicely (student)	Univ. of Alaska	Venusian Volcanoes

Venus Flagship Mission Concept Goals

1. History of volatiles and liquid water on Venus and determine if Venus was habitable.
2. Composition and climatological history of the surface of Venus and the present-day couplings between the surface and atmosphere.
3. The geologic history of Venus and whether Venus is active today.



Potential
Launch 2023-2032
Cost goal: ~$2B

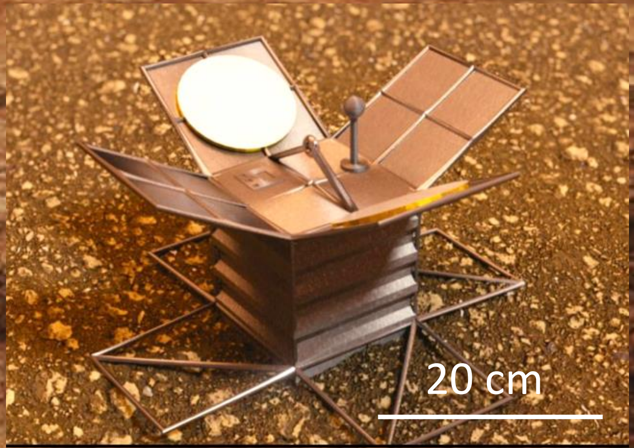
1 Orbiter
2 Orbiting SmallSats
2 Short-lived landers/Probes
1 Balloon
1 Long-lived lander (LLISSE)

Three landers, two sites

- Short lived (hours) ala Venera on plains and tessera
- Descent and landed imaging
- Mineralogical/chemical instrumentation TBD

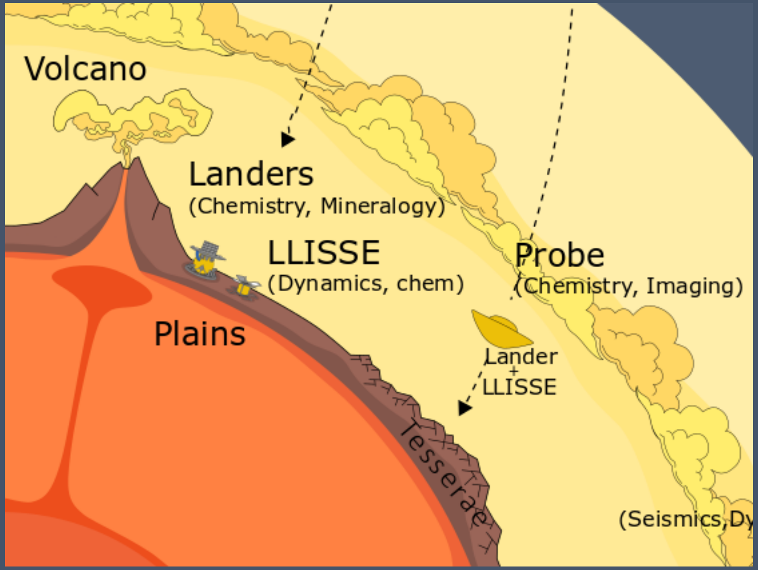
Venera 14 Lander Rests Silently by Steven Hobbs

- Long Lived in situ Solar System Explorer (LLISSE)
- To be delivered with plains lander for months
- Meteorology chemical sensors



Kremic et al. (2016) VEXAG

Two Landing Sites

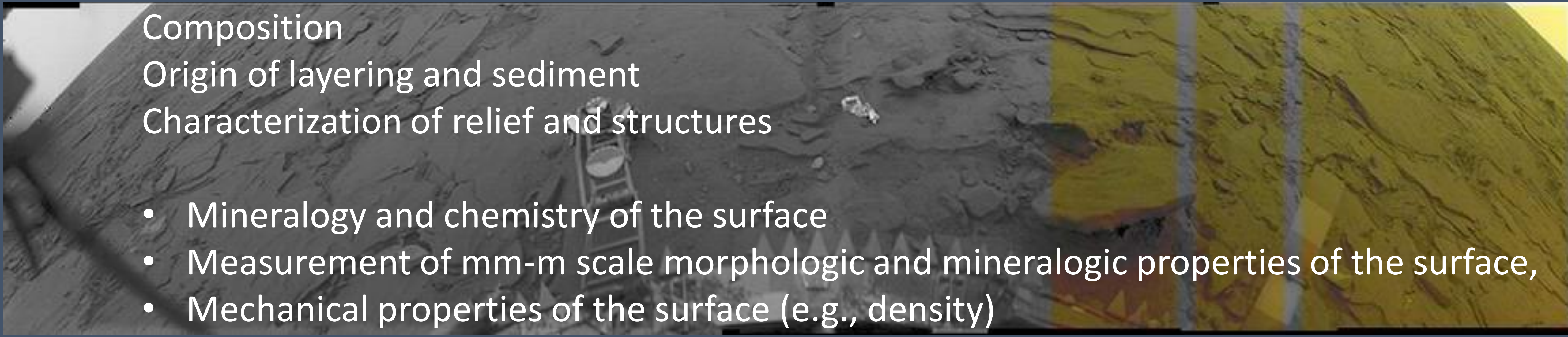


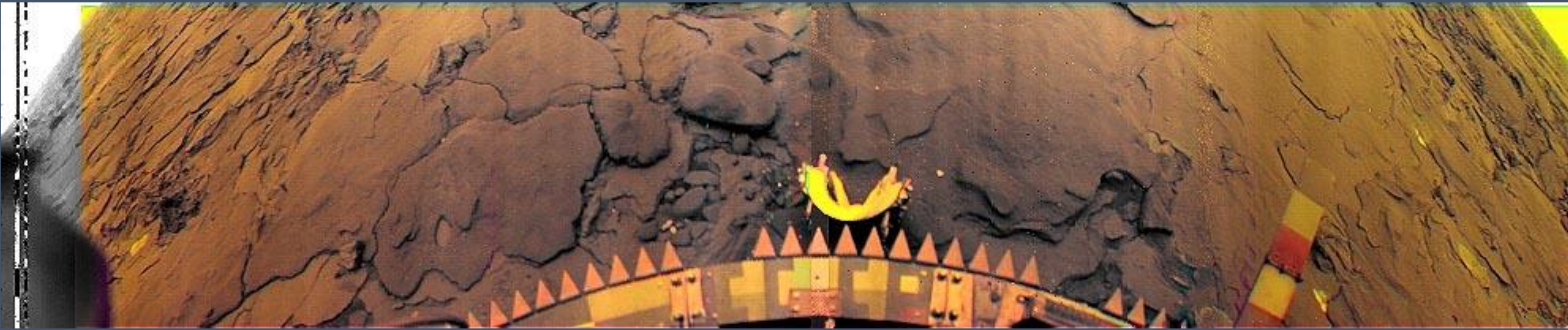
- Plains site
  - Planetary “bulk” chemical and volatile composition
  - New instrumentation to compliment Venera/Vega
  - Landing site relatively safe
- Tessera site
  - Oldest terrain of unknown composition
  - Potentially felsic, sedimentary, present during wetter period
  - Rough, more dependent on high resolution SAR imaging for safe landing

Lander Goals

Composition
Origin of layering and sediment
Characterization of relief and structures

- Mineralogy and chemistry of the surface
- Measurement of mm-m scale morphologic and mineralogic properties of the surface,
- Mechanical properties of the surface (e.g., density)





Venera 14 – 3/5/82 (~0.5 cm/line pair)

Plains Sites

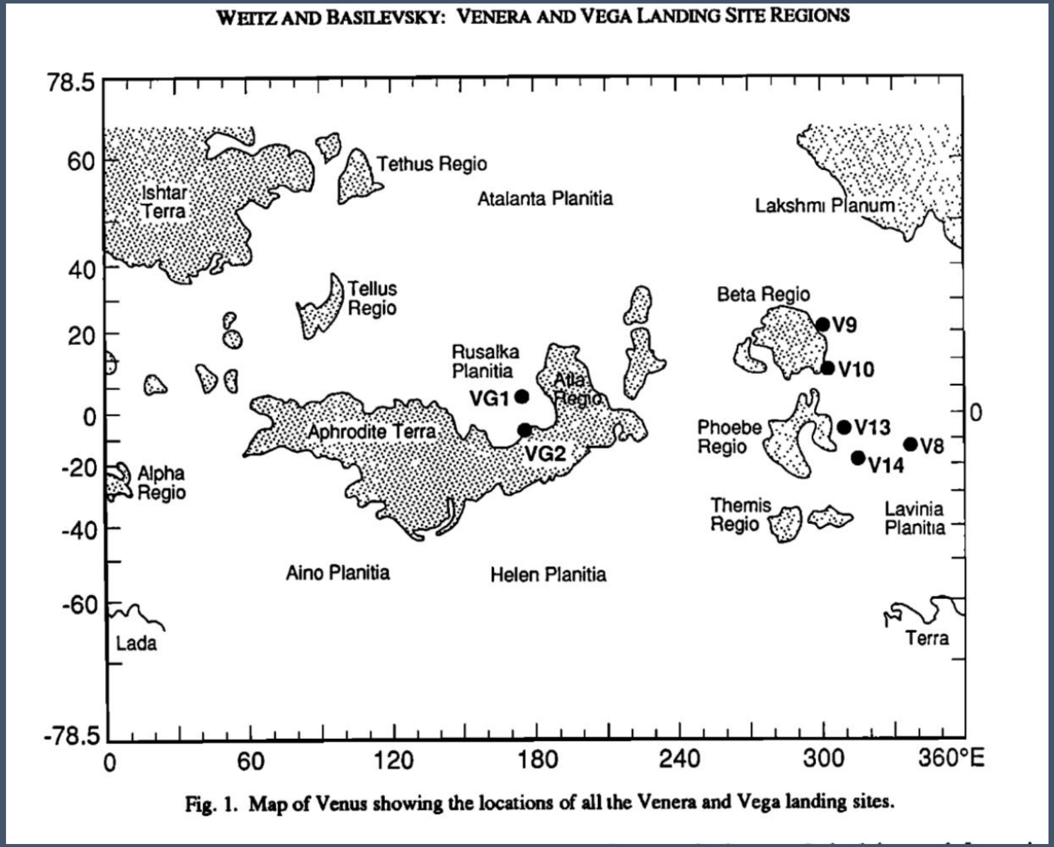
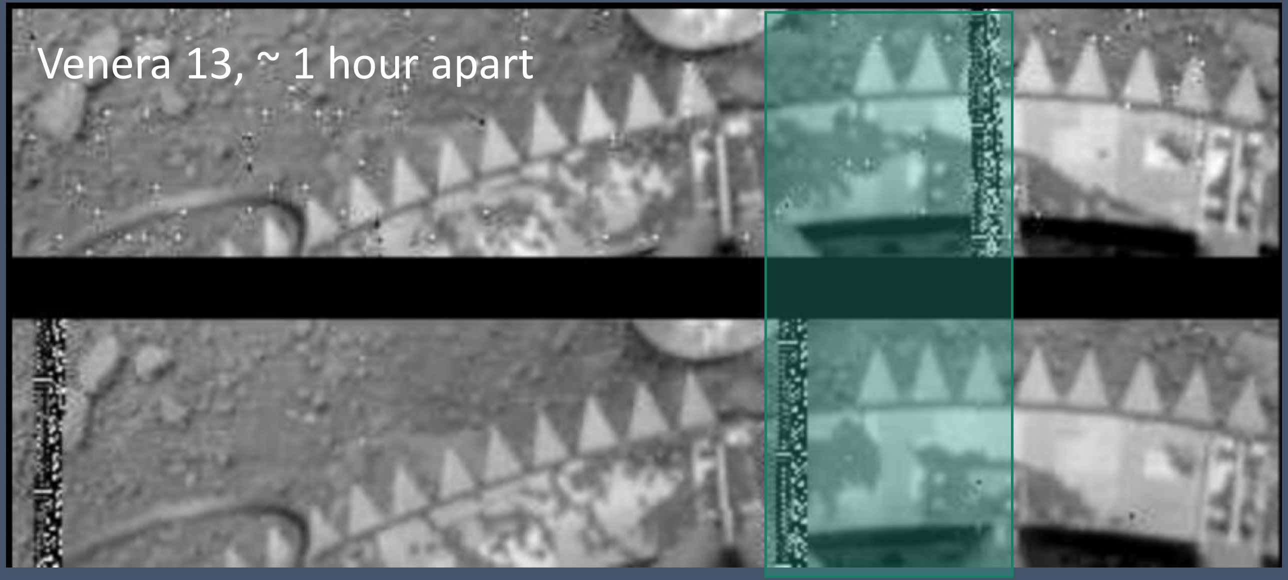


Fig. 1. Map of Venus showing the locations of all the Venera and Vega landing sites.

Regional, voluminous plains
Older vs newer plains
Previously visited plains?

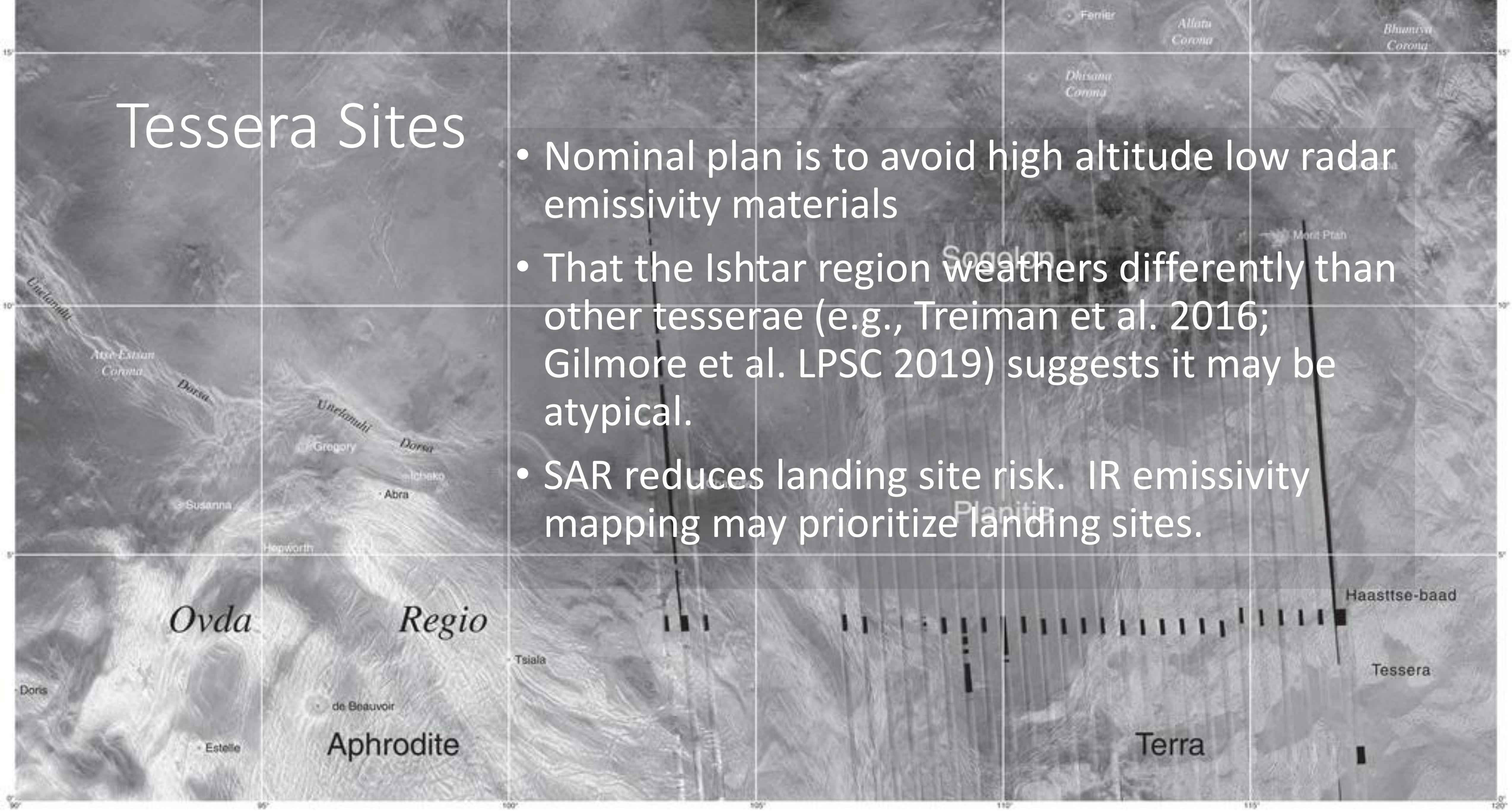
LLISSE – avoid oroclinal winds?
Look for transient phenomena



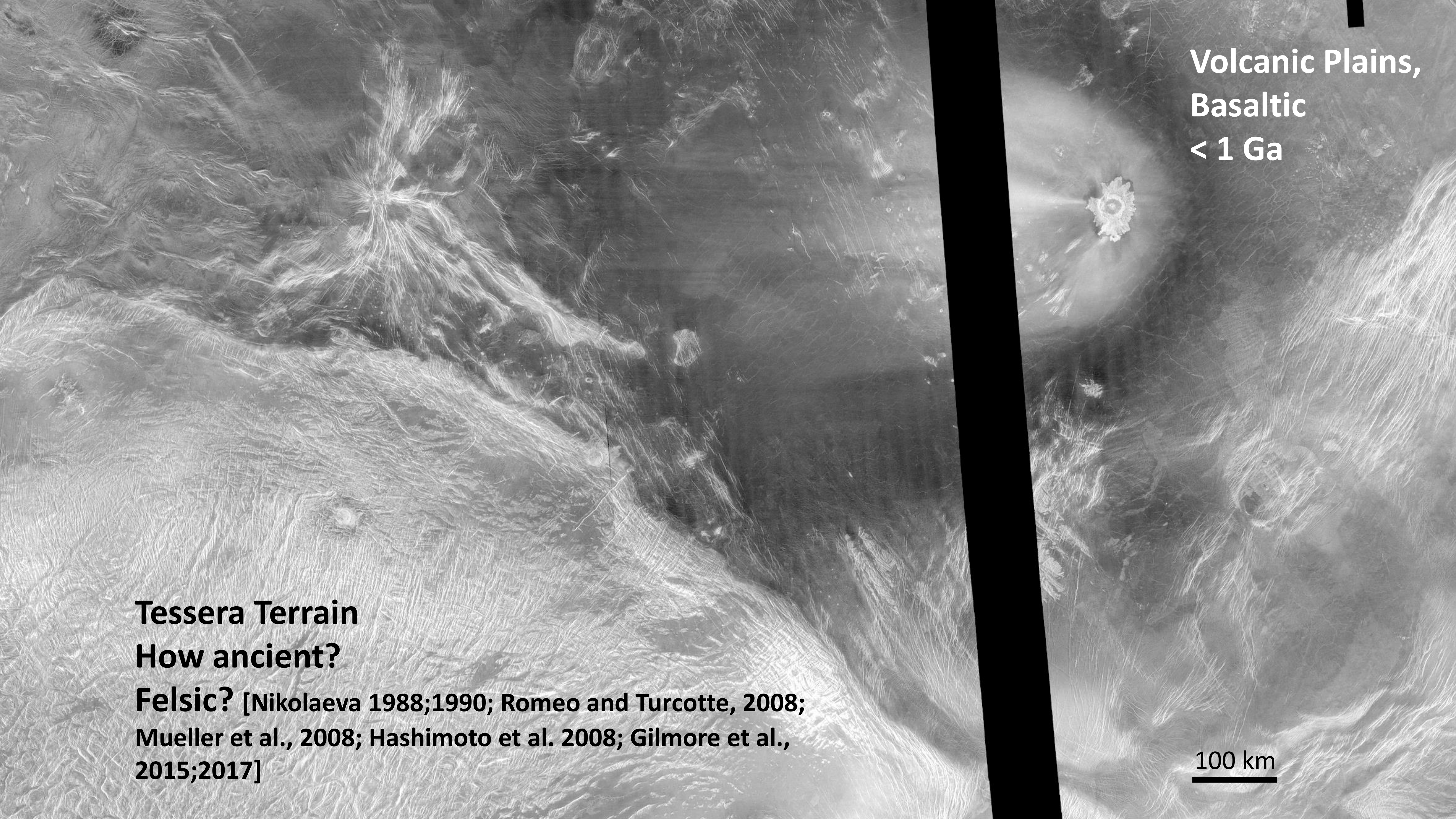
http://mentallandscape.com/V_Venera11.htm

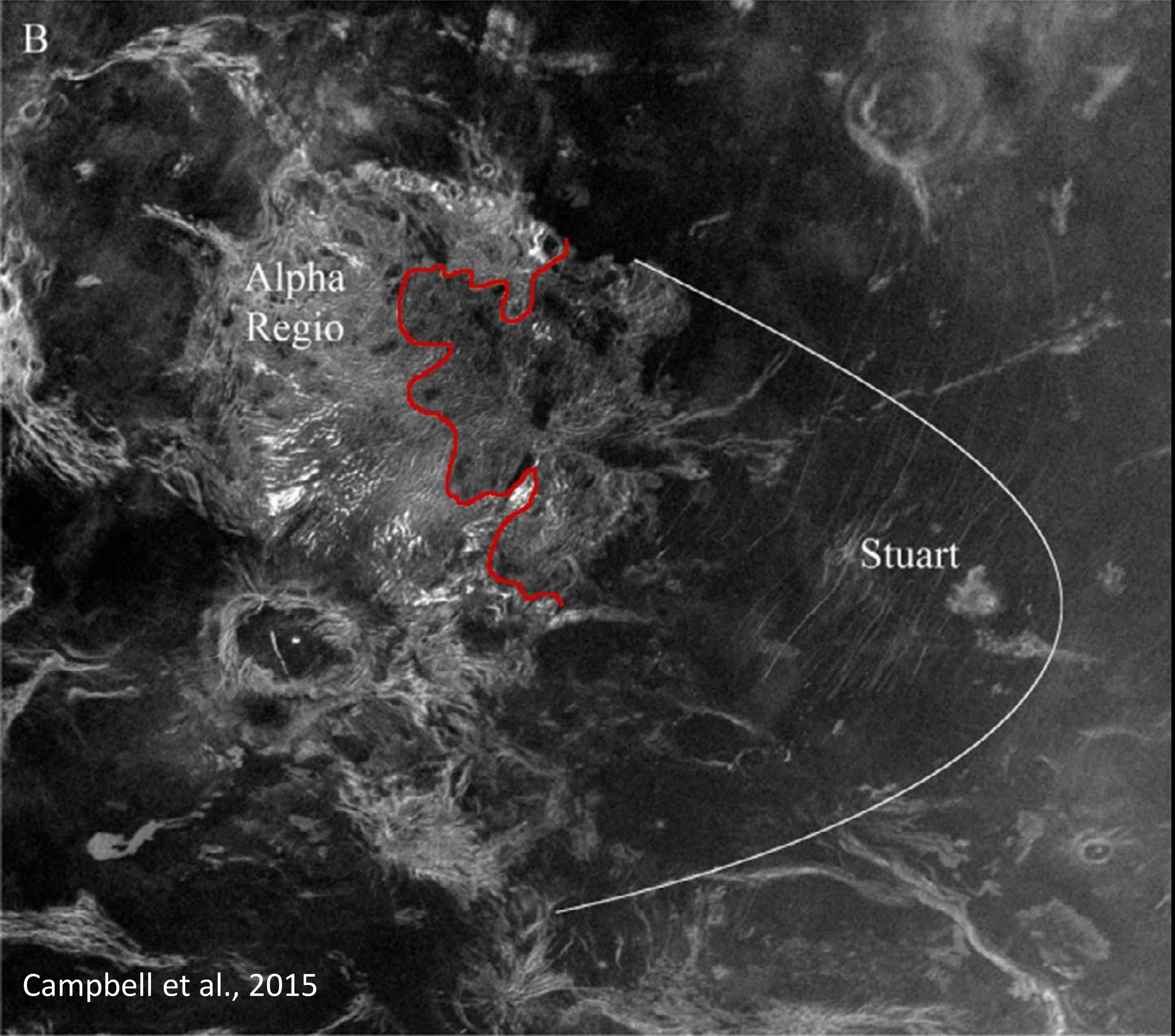
Tessera Sites

- Nominal plan is to avoid high altitude low radar emissivity materials
- That the Ishtar region weathers differently than other tesserae (e.g., Treiman et al. 2016; Gilmore et al. LPSC 2019) suggests it may be atypical.
- SAR reduces landing site risk. IR emissivity mapping may prioritize landing sites.



Niobe Planitia, V-23


Volcanic Plains,
Basaltic
< 1 Ga
Tessera Terrain
How ancient?
Felsic? [Nikolaeva 1988;1990; Romeo and Turcotte, 2008; Mueller et al., 2008; Hashimoto et al. 2008; Gilmore et al., 2015;2017]
100 km



Campbell et al., 2015

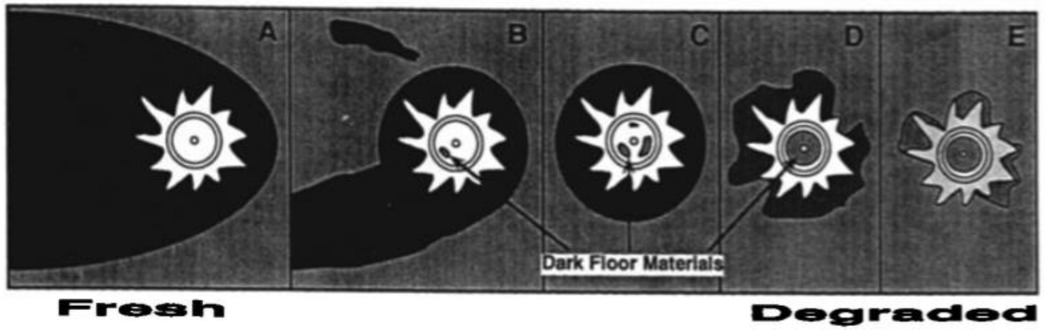
Stuart is one of the 49 parabolas visible in backscatter identified by Campbell et al., 1992

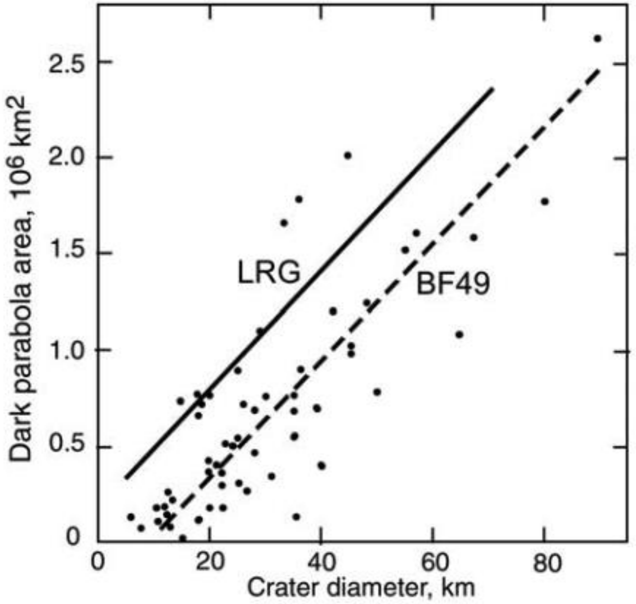
~5% of craters have parabolas yielding parabola lifetime to 10s Ma [Arvidson et al. 1992]

Parabolas are removed with time

Izenberg et al: Impact Crater Degradation on Venusian Plains

Crater Degradation Model





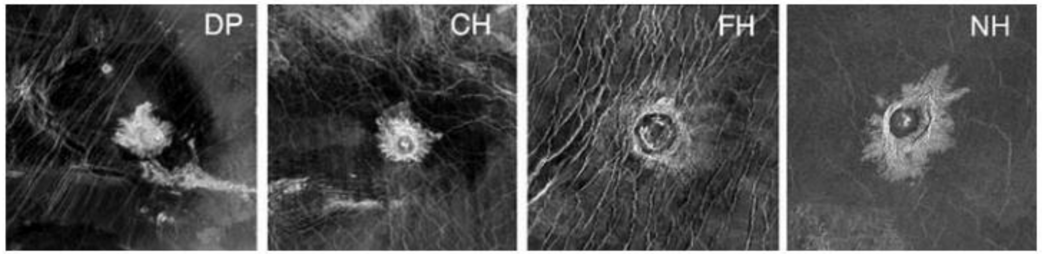


Figure 1. Morphologic/age sequence of craters: DP, with dark parabola (crater Stuart); CH, with clear dark halo (Caccini); FH, with faint halo (Barrymore); with no halo (Rand).

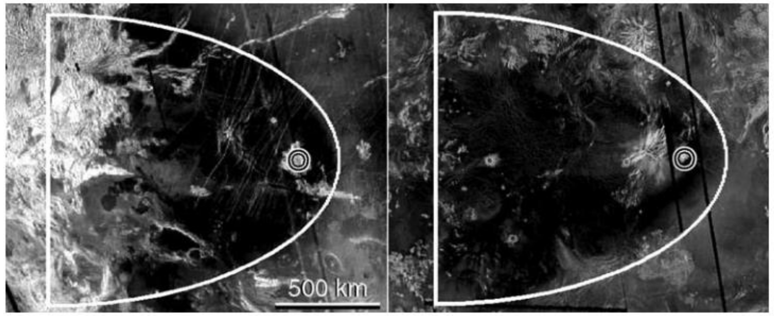
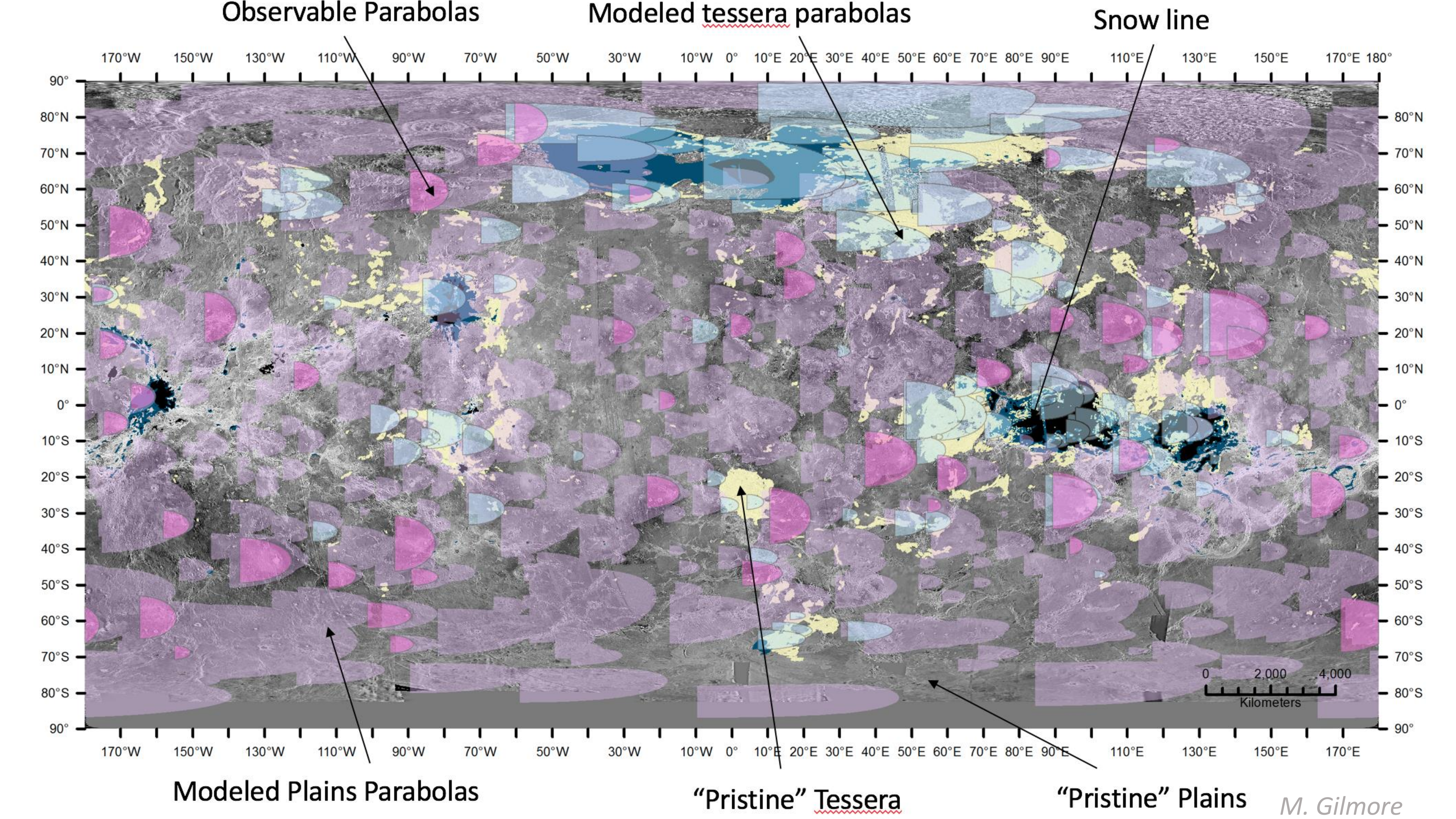
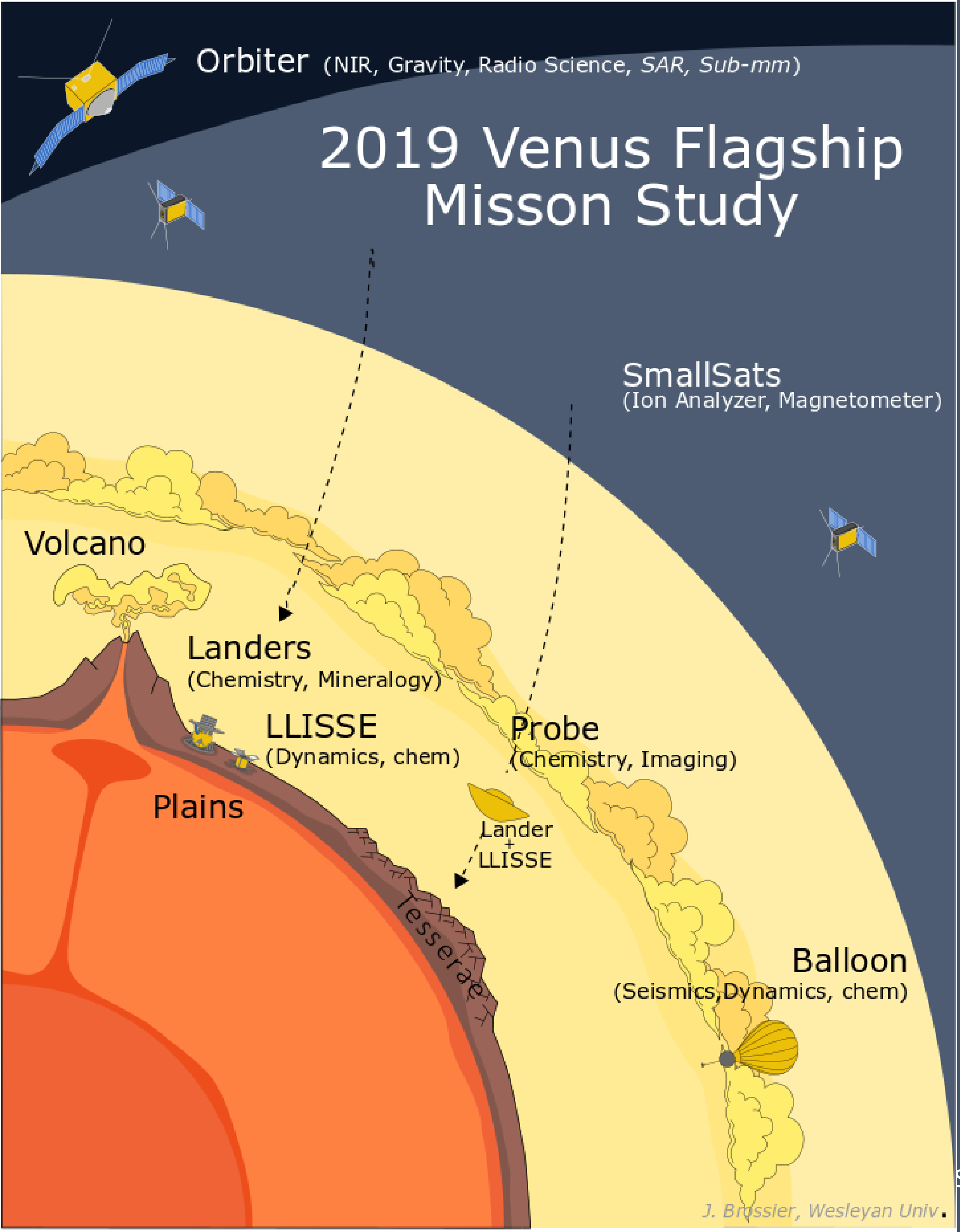


Figure 3. Model parabolas around craters (left) Stuart and (right) Bathsheba.



Observable Parabolas
Modeled tessera parabolas
Snow line
Modeled Plains Parabolas
"Pristine" Tessera
"Pristine" Plains
0 2,000 4,000
Kilometers
170°W 150°W 130°W 110°W 90°W 70°W 50°W 30°W 10°W 0° 10°E 20°E 30°E 40°E 50°E 60°E 70°E 80°E 90°E 110°E 130°E 150°E 170°E 180°
90° 80°N 70°N 60°N 50°N 40°N 30°N 20°N 10°N 0° 10°S 20°S 30°S 40°S 50°S 60°S 70°S 80°S 90°
M. Gilmore



- 3 landers – two short-lived, 1 LLISSE
- Orbital data to select safe and scientifically high priority sites.
- Baseline landing on plains and tessera terrain.