GMAP
Geological Mapping

Geologic mapping on Venus

Piero D'Incecco (INAF)

2023 GMAP Planetary Geologic Mapping Winter School

Friday - 3 February 2023

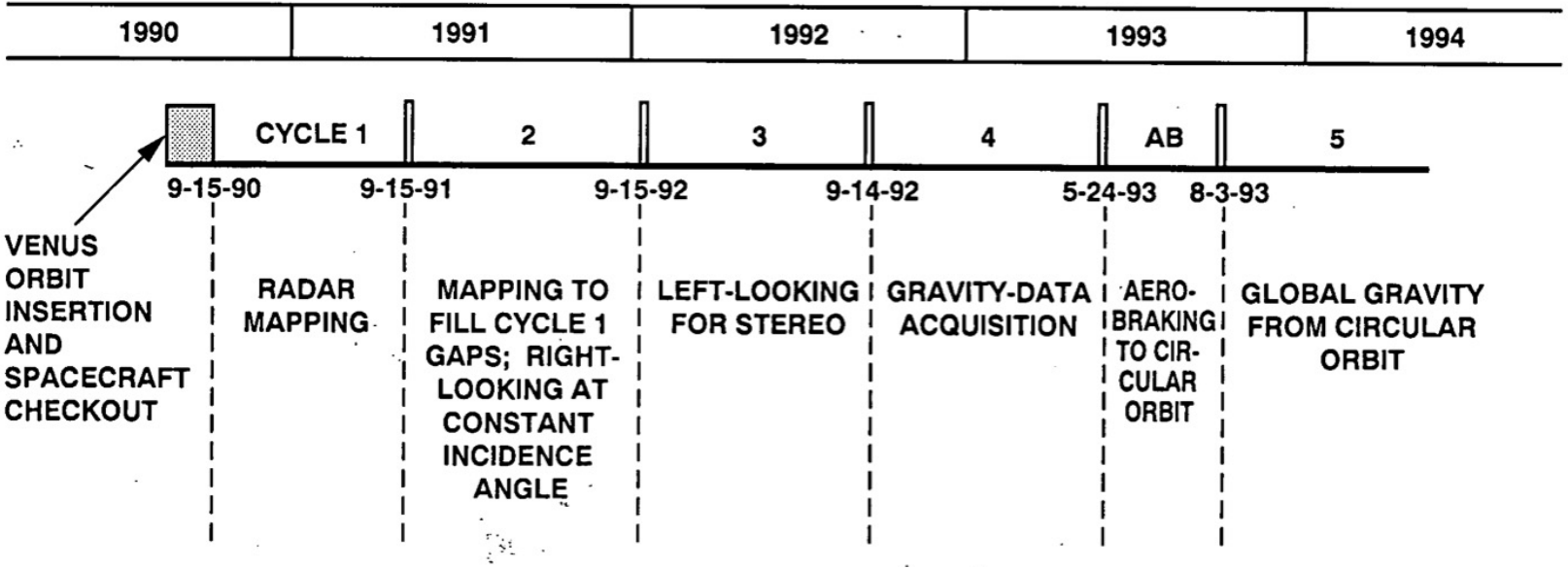
GMAP

Geological Mapping

Acquisition and interpretation of Magellan radar images

GMAP
Geological Mapping

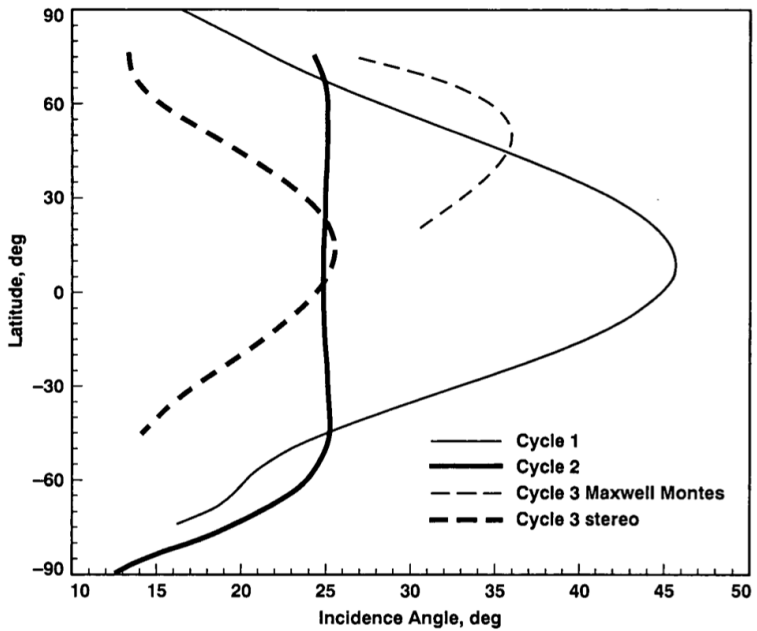
Mission mapping baseline and gravity-data acquisition plan. ***Ford et al., 1993***



GMAP
Geological Mapping

Ford et al., 1993

Magellan SAR incidence angles as a function of latitude for the three imaging cycles.



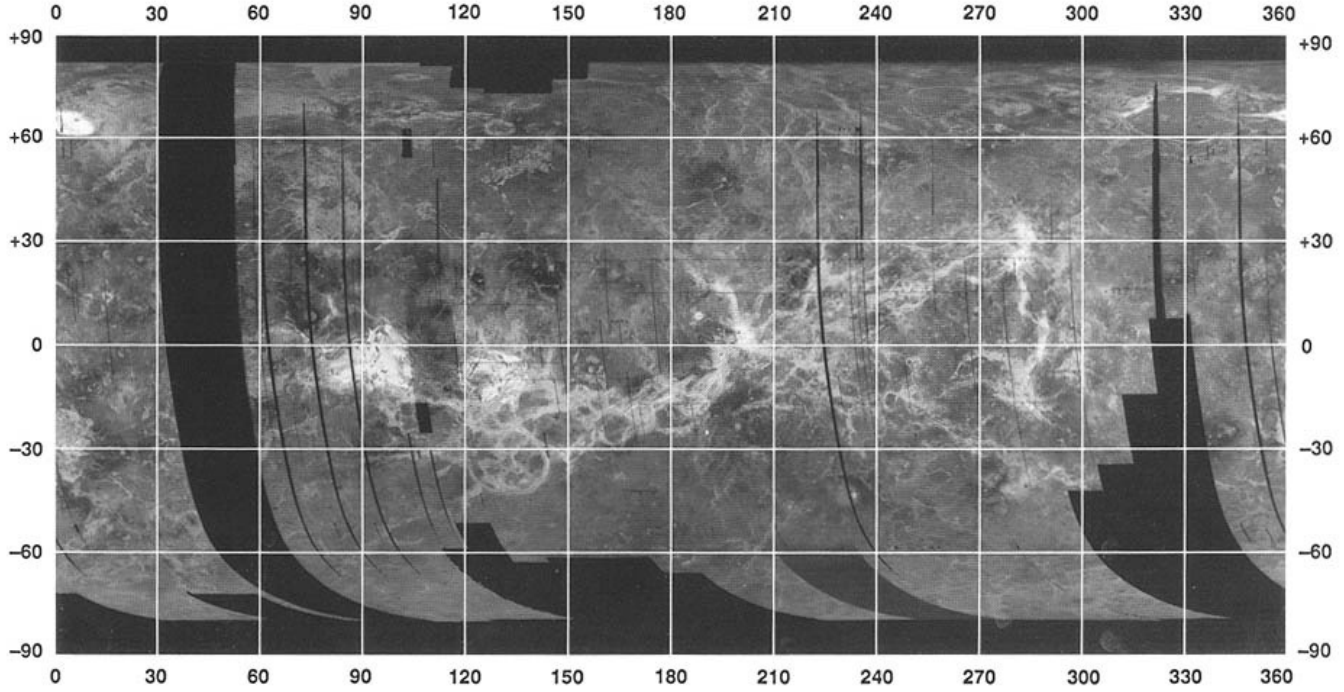
Magellan SAR incidence angle profiles

Latitude, deg	Incidence angle,[a] deg			
	Cycle 1	Cycle 2	Cycle 3, Maxwell Montes	Cycle 3, stereo
90	16.5			
85	18.5			
80	20.2			
75	22.0	24.4	27.1	13.4
70	23.9	24.9	30.8	13.5
65	26.0	25.1	33.4	14.1
60	28.3	25.1	35.1	15.2
55	30.8	25.1	35.9	16.6
50	33.3	25.1	36.1	18.2
45	35.8	25.1	35.8	19.8
40	38.1	25.1	35.1	21.4
35	40.3	25.0	34.2	22.7
30	42.1	25.0	33.1	23.9
25	43.6	25.0	31.9	24.8
20	44.8	24.9	30.6	25.3
15	45.5	24.9		25.6
10	45.7	24.9		25.5
5	45.6	24.9		25.2
0	44.9	24.9		24.5
−5	43.8	24.9		23.6
−10	42.3	24.9		22.6
−15	40.4	25.0		21.4
−20	38.1	25.1		20.1
−25	35.5	25.1		18.7
−30	32.8	25.2		17.4
−35	30.1	25.3		16.2
−40	27.5	25.3		15.2
−45	25.1	25.3		14.3
−50	23.1	25.1		
−55	21.6	24.7		
−60	20.5	24.1		
−65	19.7	23.1		
−70	18.5	21.6		
−75	16.3	19.7		
−80		17.4		
−85		14.8		
−90		12.7		

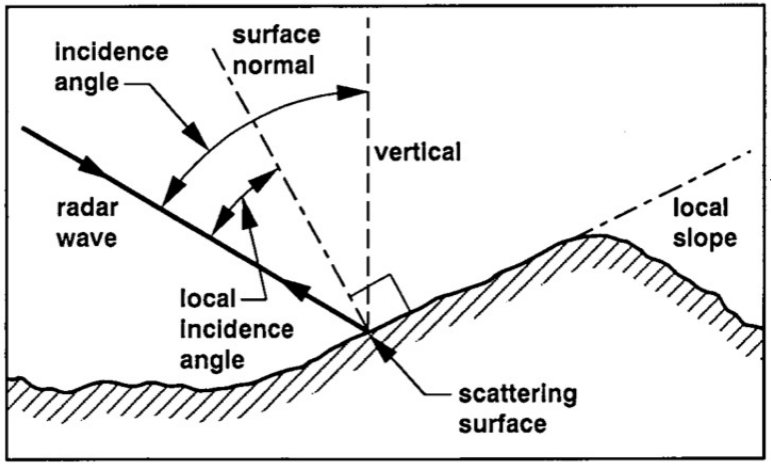
Incidence angle values are representative for each cycle, within ±0.5 deg.

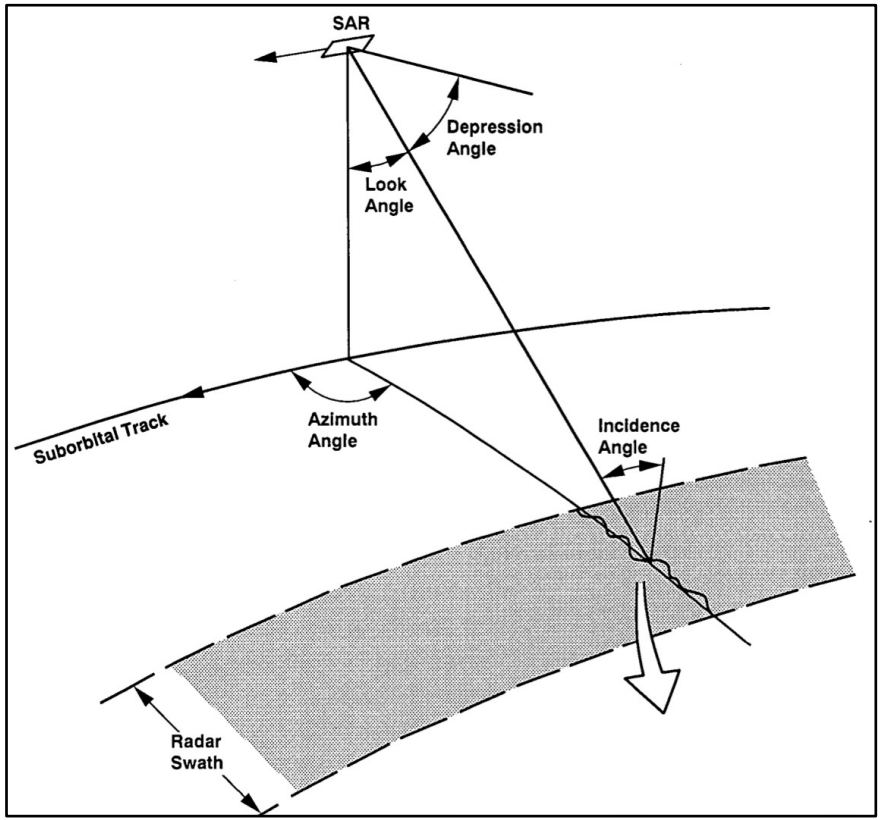
GMAP
Geological Mapping

Mosaic of Magellan Cycle-1 coverage (left-looking).
Ford et al., 1993.



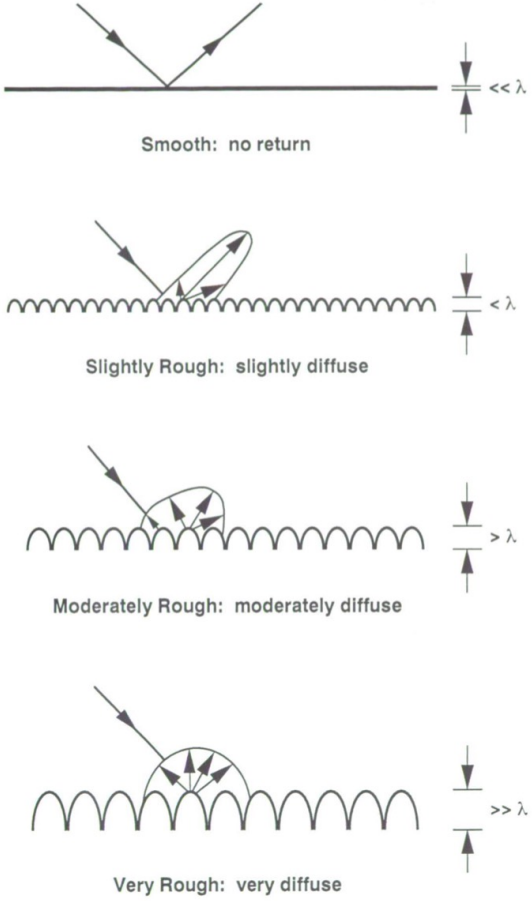
GMAP
Geological Mapping



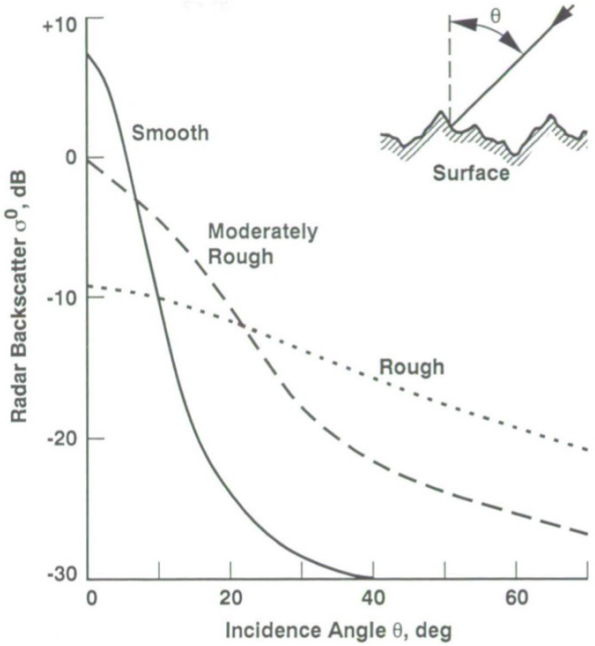


Geometry of radar image acquisition. The depression angle is complementary to the look angle; the incidence angle may be affected by planetary curvature. Local incidence angle may be affected by local topography. *Ford et al., 1993*

GMAP
Geological Mapping



Surface roughness effects on radar backscatter. Sur- faces whose roughness is much less than the radar wavelength scatter in the specular direction. Rougher surfaces scatter more energy in all directions, including the direction back to the receiving antenna. *Ford et al., 1993.*



Radar backscatter as a function of incidence angle for representative surfaces. For angles less than about 25 deg, **smoother surfaces have greater backscatter than rougher surfaces.** *Ford et al., 1993.*

GMAP
Geological Mapping

The variations in radar brightness are caused by three main factors:

1) surface roughness

2) electrical properties of the target material

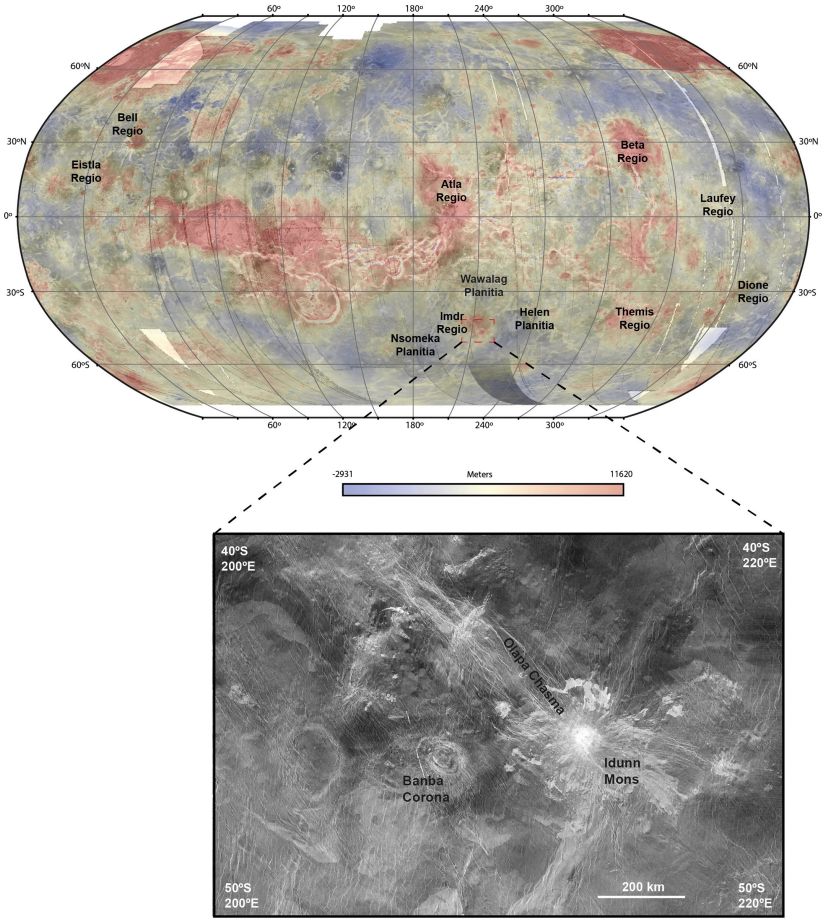
3) topographic effects

GMAP
Geological Mapping

Imdr Regio: an example for geologic mapping and stratigraphic reconstruction on Venus

GMAP

Geological Mapping

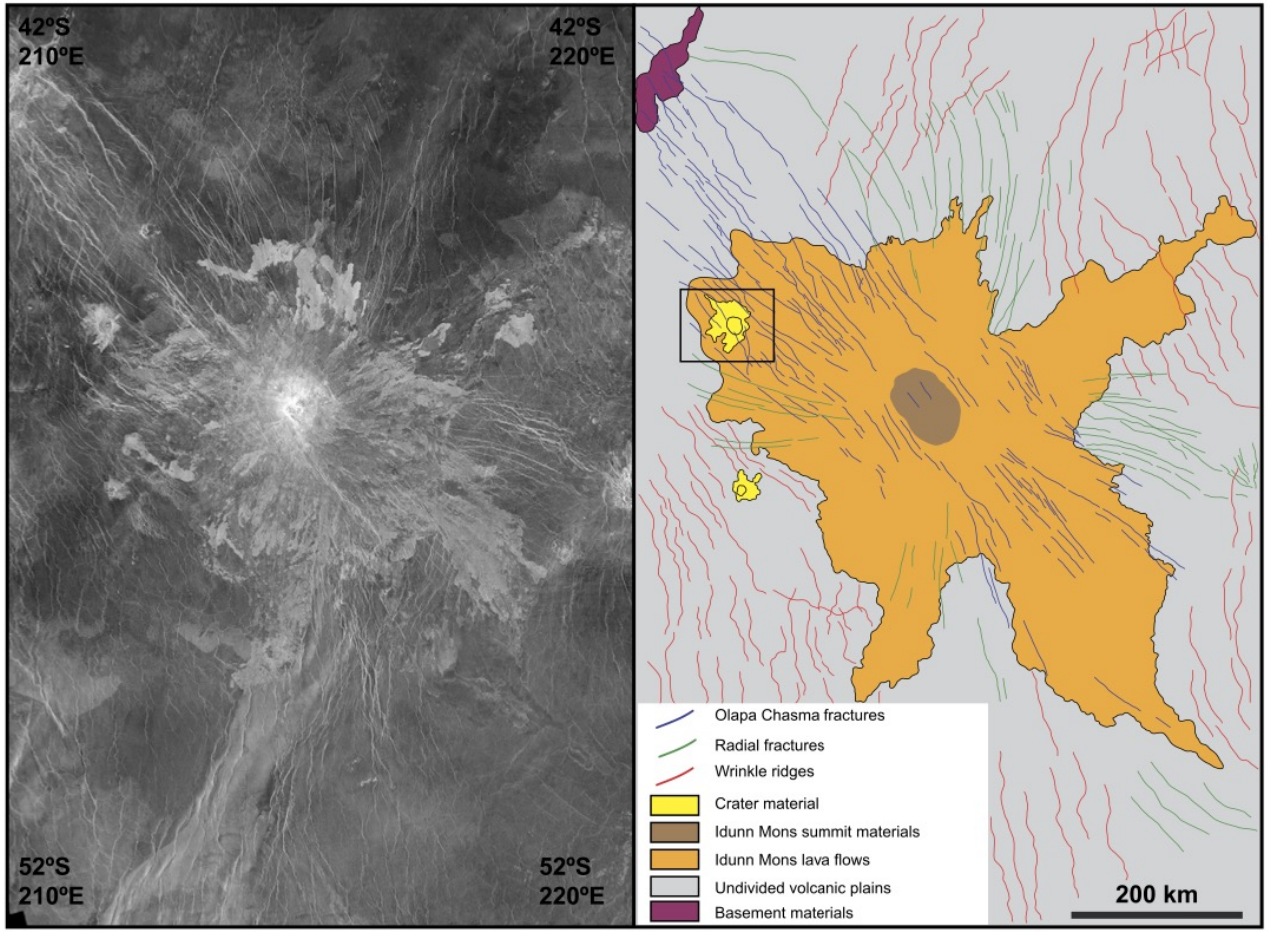


Up: Location of the principal large igneous rises on Venus (Magellan Radar-altimetry composite image in Robinson projection).

Down: Location of Idunn Mons and Olapa Chasma in Imdr Regio (Left-looking Magellan radar image).

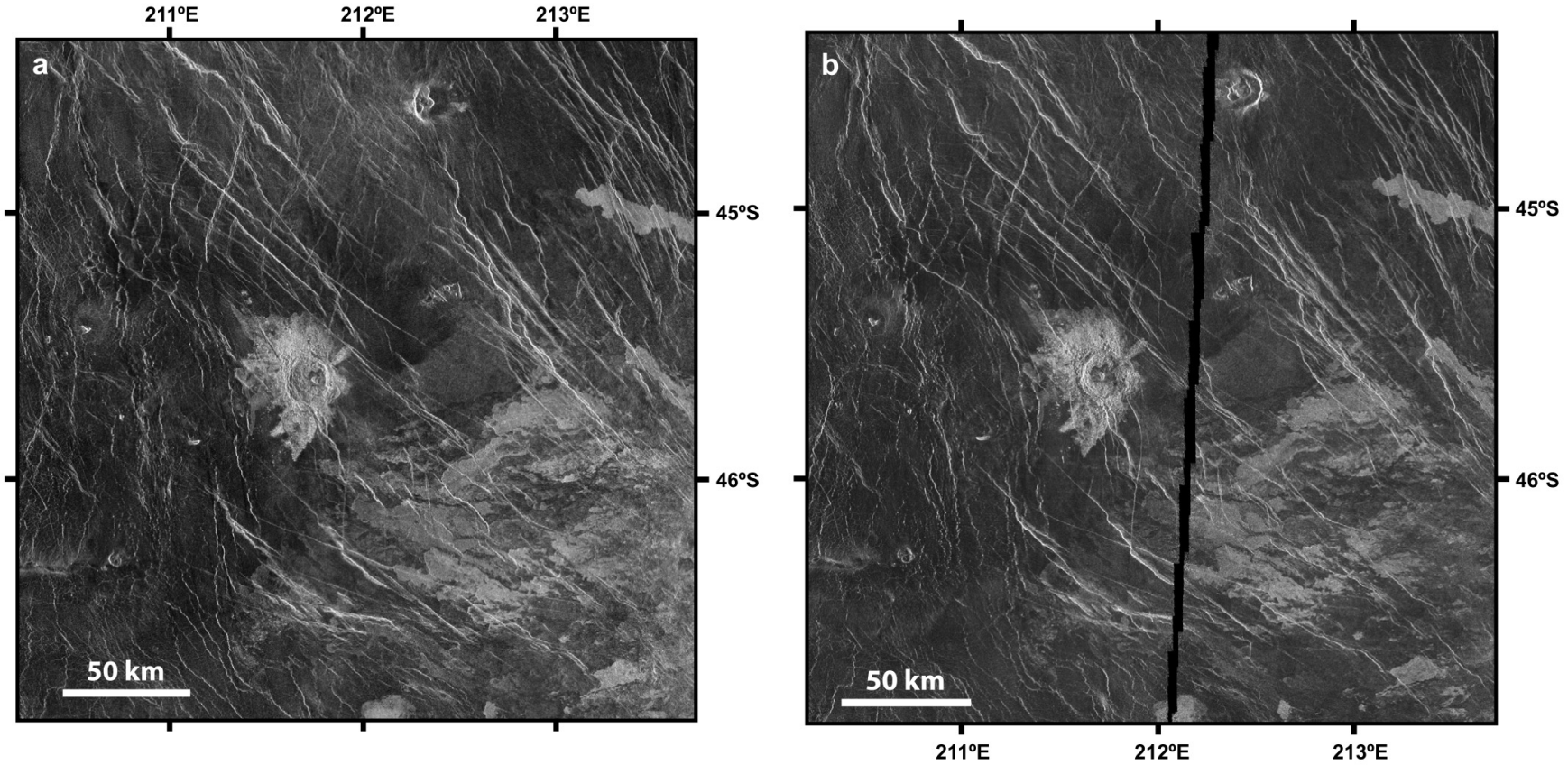
López et al., 2021

GMAP
Geological Mapping



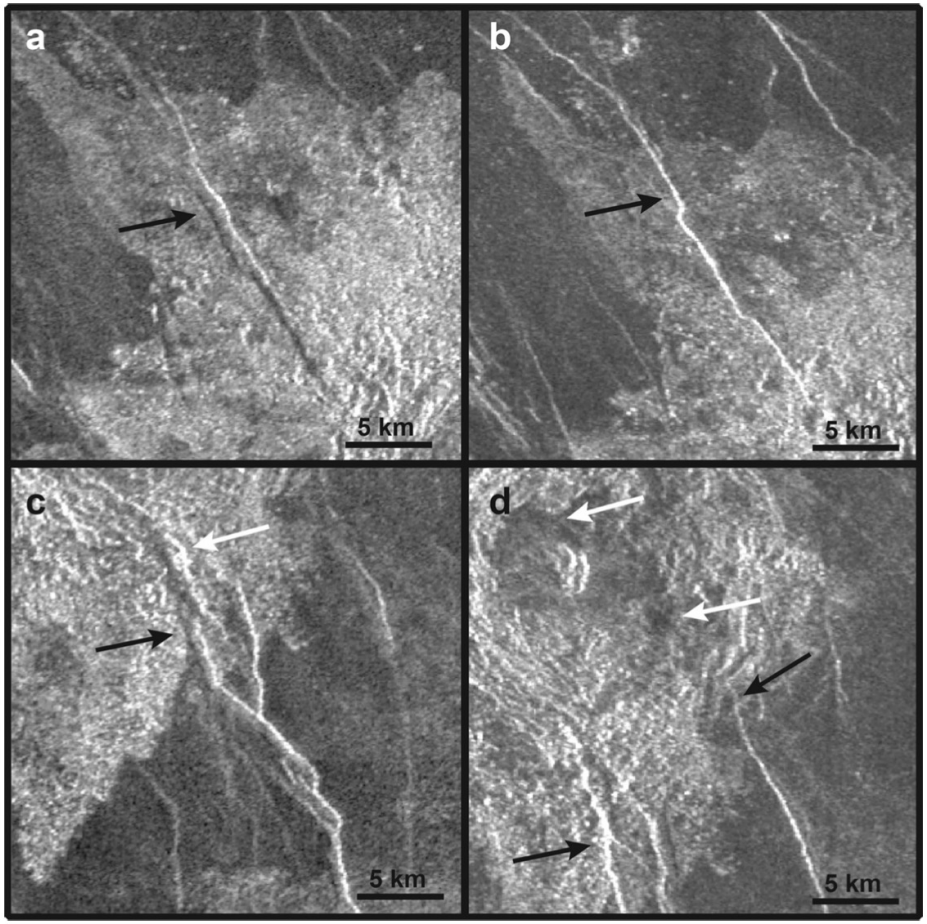
Regional view of the Olapa Chasma-Idunn Mons volcano-tectonic system. Magellan Synthetic Aperture Radar (SAR) left look image at 75 m/pixel.

D'Incecco et al., 2020.



Location area of Sandel crater (45.7◦S/211.7◦E). Magellan Synthetic Aperture Radar (SAR) left-look (a) and right-look (b) images at 75 m/pixel. The presence of a circular well defined radar dark halo characterizes impact craters. *D'Incecco et al., 2020.*

GMAP
Geological Mapping



Detail of fractures and graben intersecting the impact materials and the rim of Sandel crater. White arrows indicate where the tectonic fracturing postdates other intersecting impact units. Black arrows indicate fracturing whose stratigraphic relationship with the impact units is uncertain. Right-looking full resolution (75 m/pixel) SAR.

D'Incecco et al., 2020.

Volcanic units

Lava flow composite unit (lfc) - Radar bright digitate lava flows originating from the OCIM system.

Plain material (pm) - Volcanic plain material of intermediate backscatter and smooth morphology. Highly deformed by grabens and fractures of the OCIM system.

Impact units

Continuous ejecta deposits (ced) - Radar bright deposits ejected during the impact event.

Crater floor material (cfm) - Radar bright deposits originating from post-impact collapse on Sandel Crater.

Other units

Dark floor material (dfm) - Radar dark layer of uncertain origin, partially covering the floor of Sandel crater.

Structures

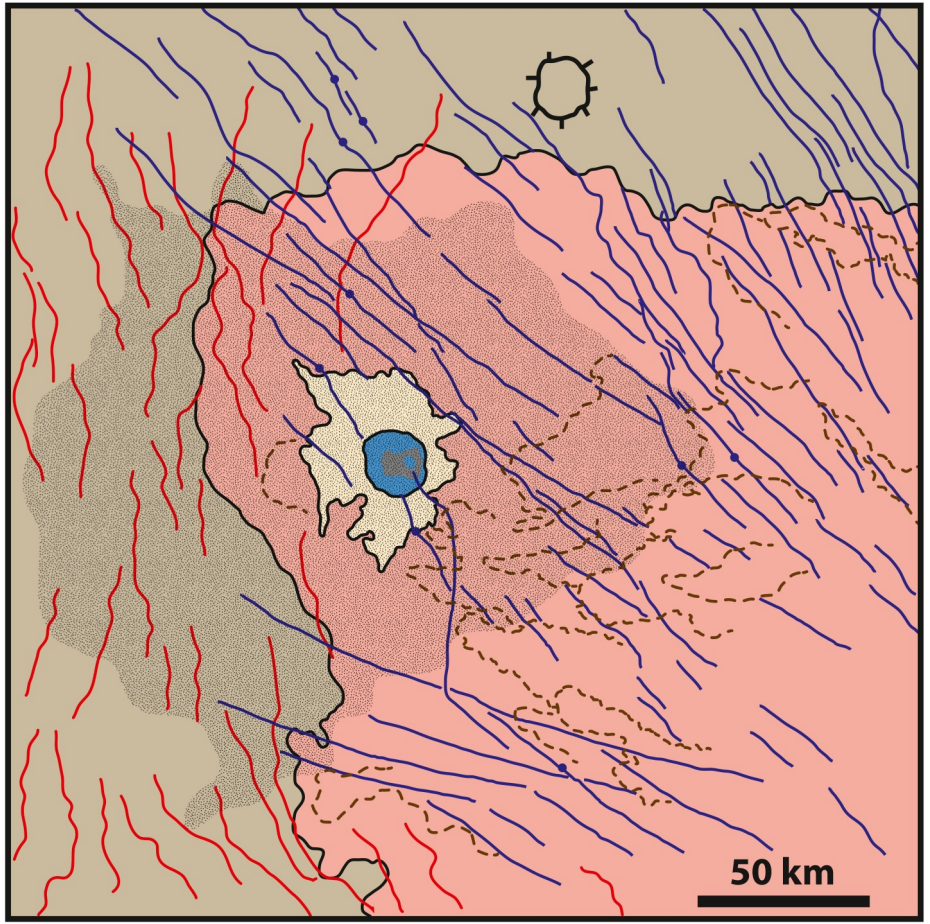
Dark halo deposits - Radar dark, thin impact layer surrounding Sandel crater.

OCIM fractures (shown with ball where interpreted as graben).

Wrinkle ridges

Lobate flows from ıdunn Mons.

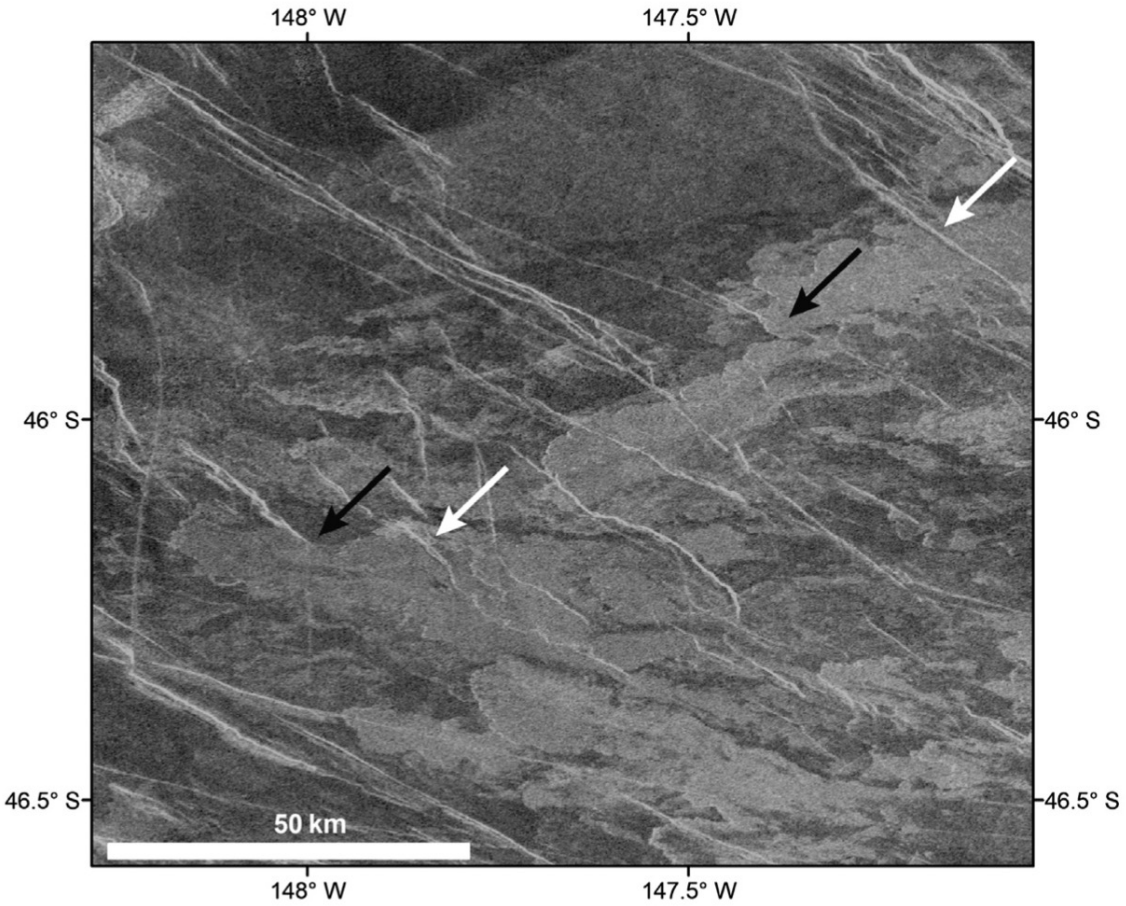
Volcanic edifice.



Geologic map of Sandel crater (45.7◦S/211.7◦E), based on the Magellan SAR left look image

D'Incecco et al., 2021

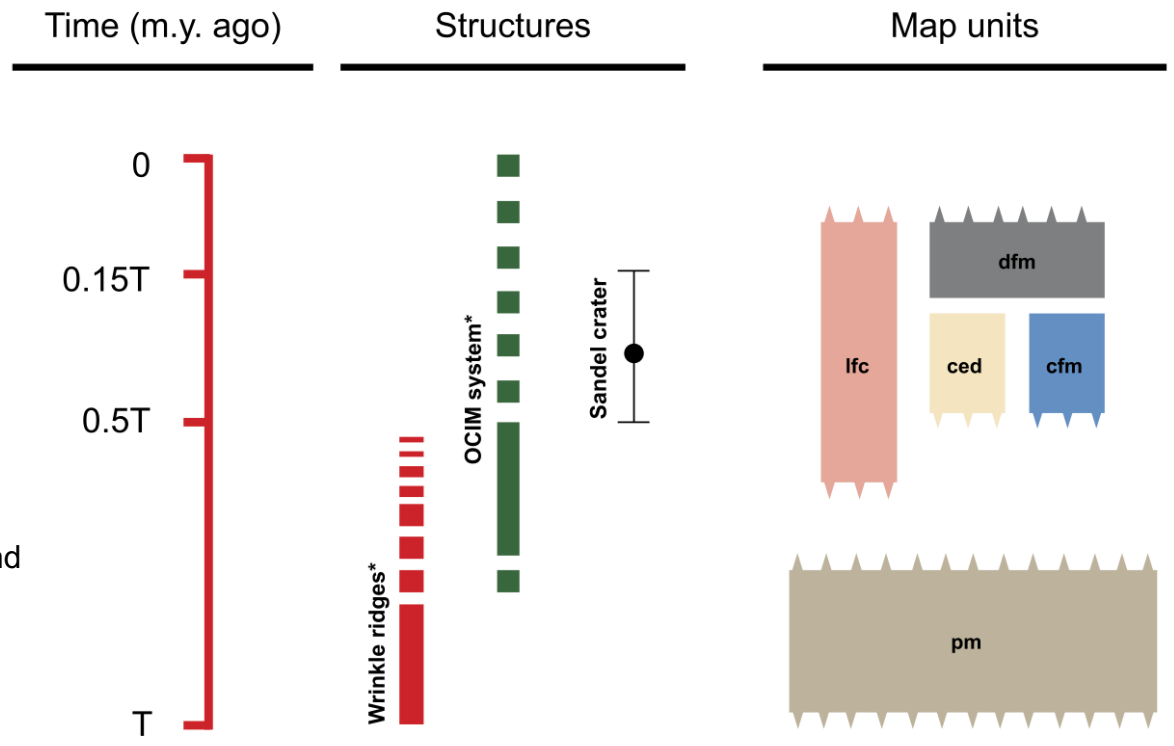
GMAP
Geological Mapping



Southeastern area of Sandel crater. Two distinct lava flows are shown, each of those bury one fracture and is cut by another fracture. Left-looking Magellan full- resolution (75 m/pixel) SAR image.

D'Incecco et al., 2020.

GMAP
Geological Mapping



Stratigraphic sequence for the map units and structures in the map area.

D'Incecco et al., 2020.

***Solid line indicates greater confience**

T= average surface model age (McKinnon et al. 1997)

GMAP
Geological Mapping

Venus, the planet where…

«Everything Burns»
(Joker in *The Dark Knight*)