LOW RADAR EMISSIVITY SIGNATURES ON VENUSIAN CORONAE

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1. Introduction

Several studies [1,2] have recognized that many of the venusian highlands display anomalous decreases in radar emissivity. This is thought to be the result of atmosphere-surface interactions at high altitudes, and hence at lower temperatures [e.g., 3-5]. These reactions are a function of rock and atmosphere compositions, and degree of weathering. The detailed variations in radar emissivity with elevation may yield insight into these characteristics. So far only the radiophysical behaviors of the tesserae, mountain belts and large volcanoes have been examined in deep [6-8].

Here we investigate a selection of coronae having reductions of radar emissivity with altitude (Fig. 1). Coronae are irregular to circular structures characterized by a complex interior zone occupied by flows, domes and tectonic ridges, and like volcanic rises, they are suspected to be surface manifestations of mantle plumes [9,10].

2. Datasets

NASA's Magellan mission, with f = 2.4 GHz and λ = 12.6 cm

- SAR images (75 m.px^{-1}) ➡ Mapping
- Emissivity (~5 km.px^{-1}) and elevation data ➡ Plots
- Temperature from Vega 2 lander data [11]

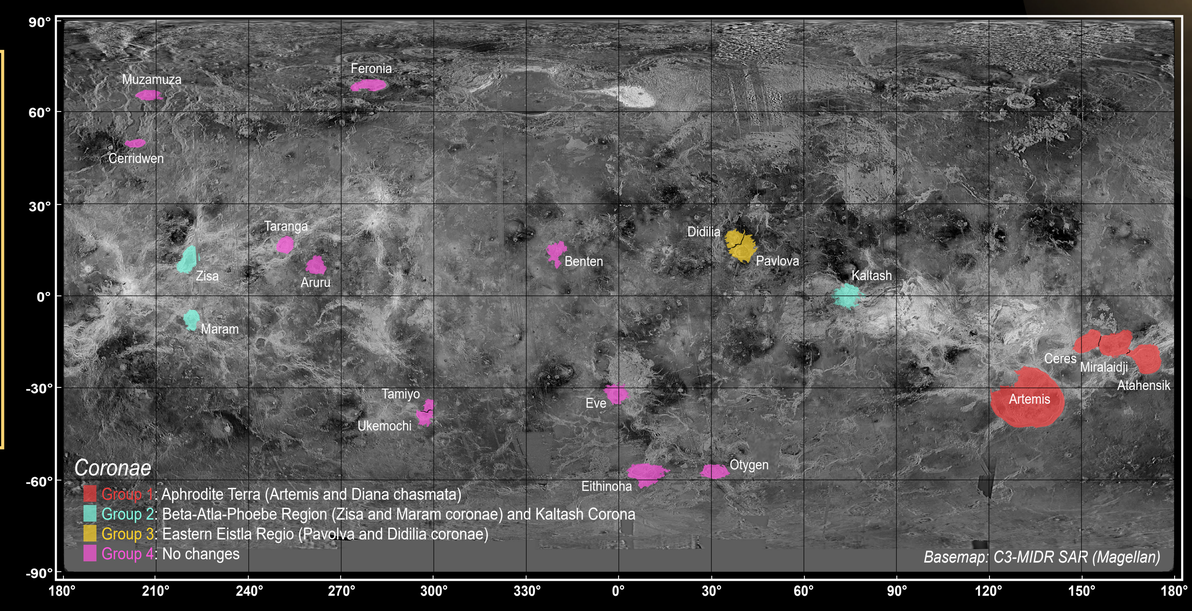
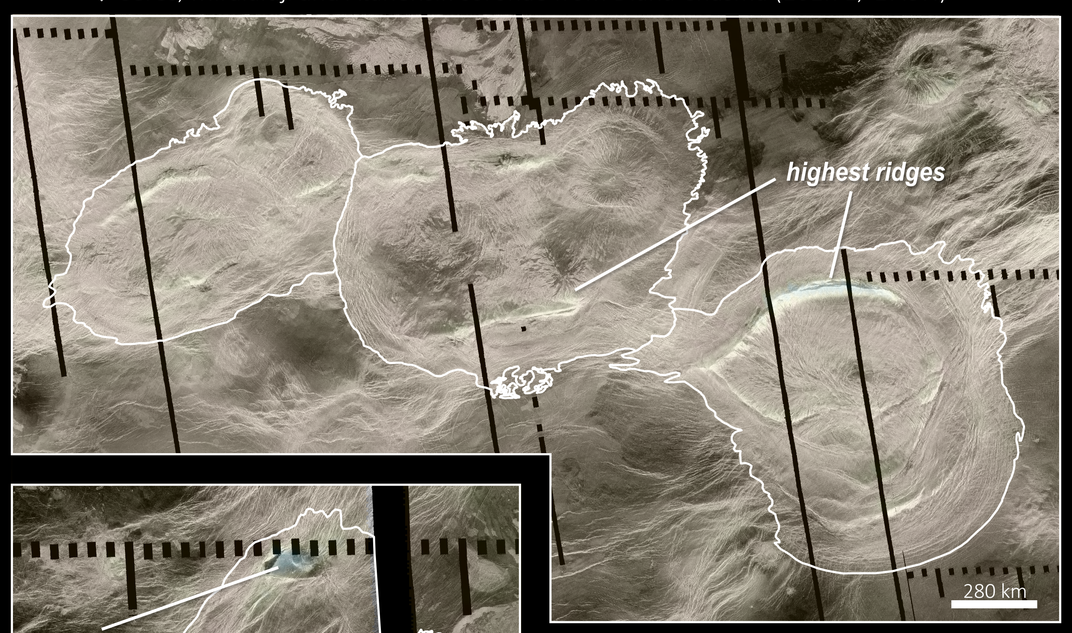
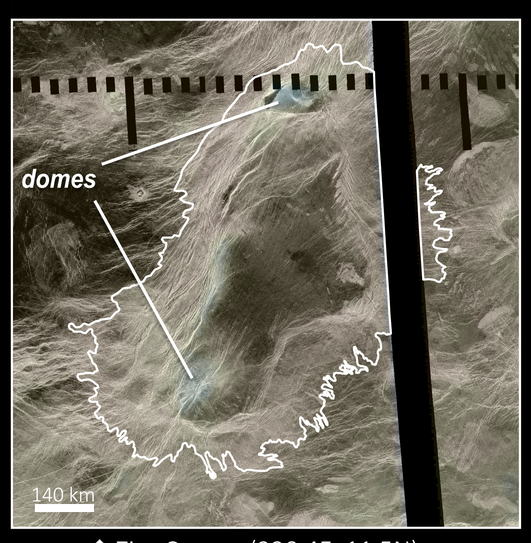


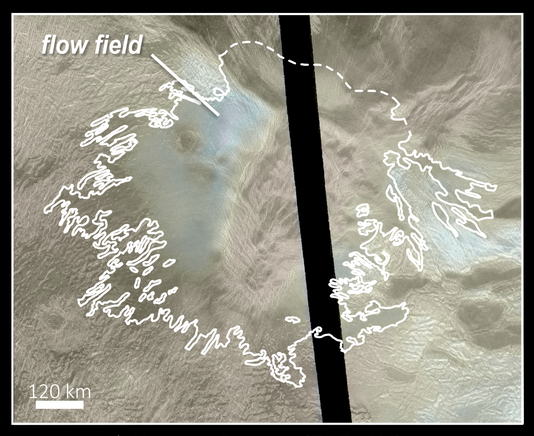
Fig. 1 - Coronae selected are filled according to their emissivity variations with increasing altitude.

⬇ Ceres, Miralaidji and Atahensik coronae from Diana Chasma (161.7E,-17.9N)





⬆ Zisa Corona (220.4E, 11.5N)

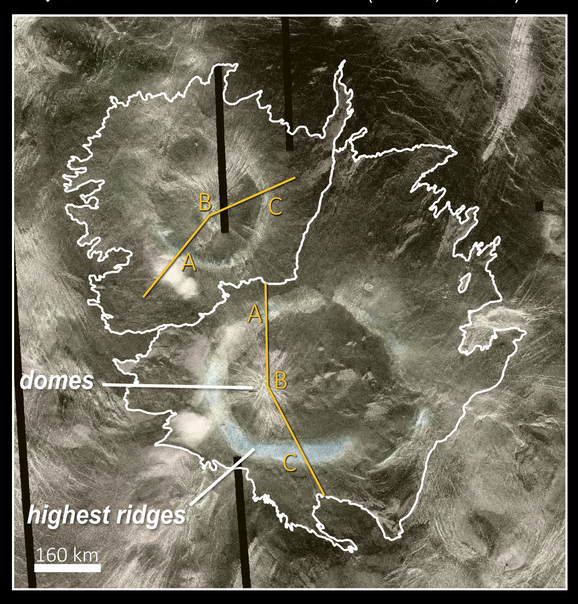


⬆ Kaltash Corona (74E, 0N)

3. Results: Low emissivity excursions

A few coronae exhibit anomalous declines in radar emissivity with altitude confined at their highest locations: topographic ridges, interior edifices (e.g., domes) or extensive flow fields (Fig. 2). As seen in Fig. 3, the elevations and magnitudes of their excursions are variable from a region to another. This allows us to group them.

⬇ Didilia and Pavlova coronae (39.4E, 16.2N)



⬇ Eve Corona (359.2E,-31.9N)

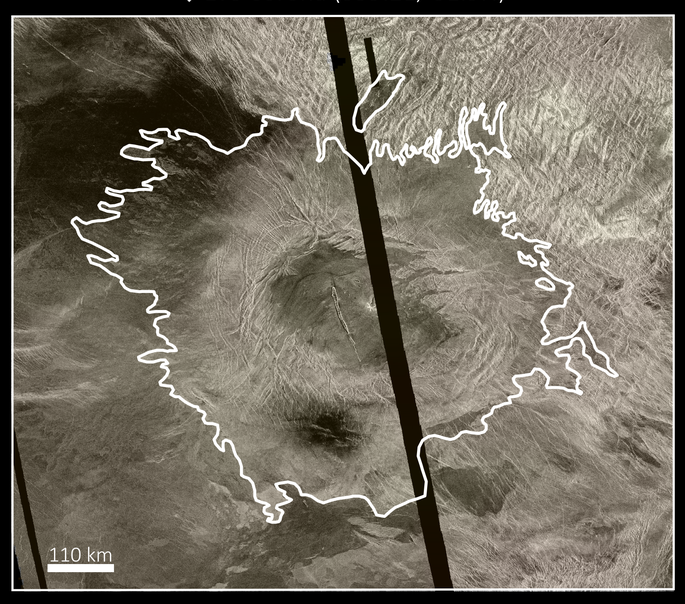
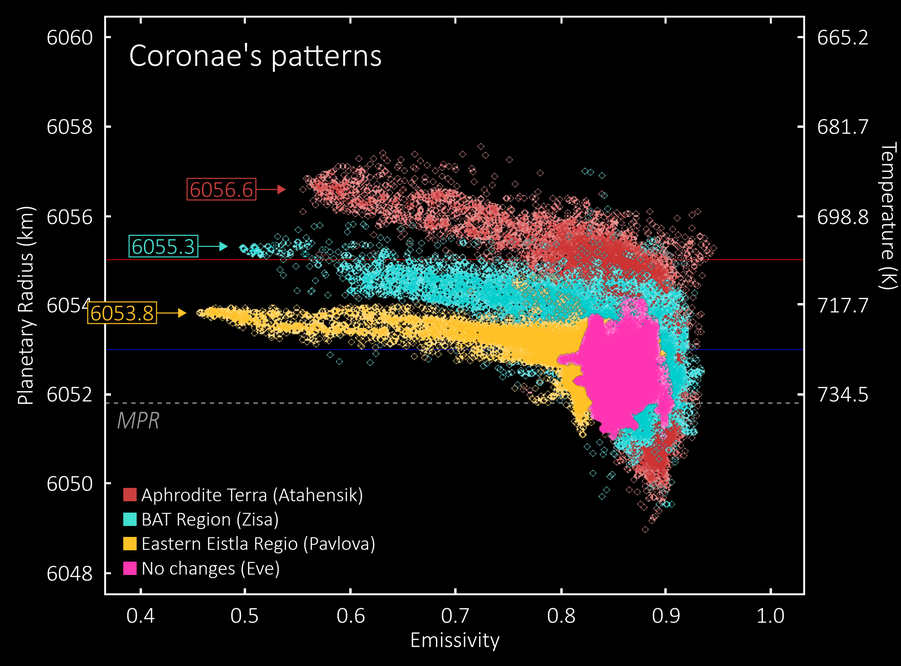


Fig. 2 - Emissivity maps overlapping SAR images of a few coronae. Extensive flow fields are outlined in white. Low emissivity excursions are shown by bluish patches and are found at the highest altitudes. (see Fig. 4 for the cross-sections in Didilia and Pavlova coronae)

Fig. 3 - Emissivity vs. Elevation

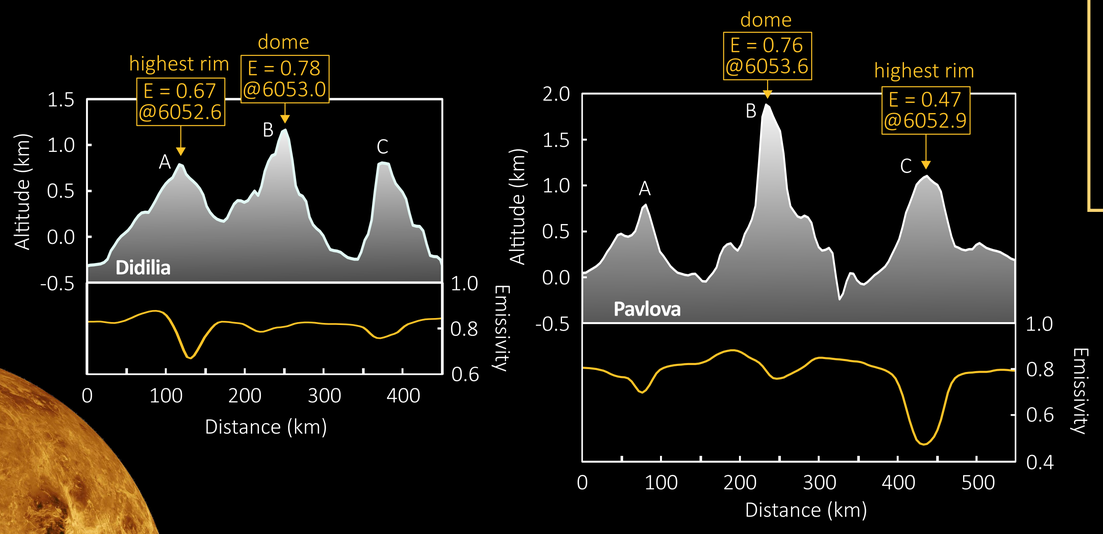


4. Classification

Elevations and magnitudes of the low emissivity excursions may provide new clues about the composition and evolution of magmas associated with the coronae. Those diverse patterns suggest different sets of low emissivity minerals in the rocks.

- Pattern 1 — Emissivity **gradually** decreases with altitude above 6055 km (red line in Fig. 3)
  This pattern resembles that on Ishtar Terra with Maxwell Mt. and Fortuna Ts. [5,7] ➡ Semiconductors?
- Pattern 2 — Emissivity **gradually** decreases with altitude above 6053 km (blue line in Fig. 3)
- Pattern 3 — Emissivity **sharply** decreases with altitude above 6053 km
- Pattern 4 — Emissivity remains **constant** and above 0.8 with altitude
  Eve's ridges are higher than 6053 km and do not present emissivity changes.
  The coronae materials may lack in low-emissivity minerals or are too young to have weathered.

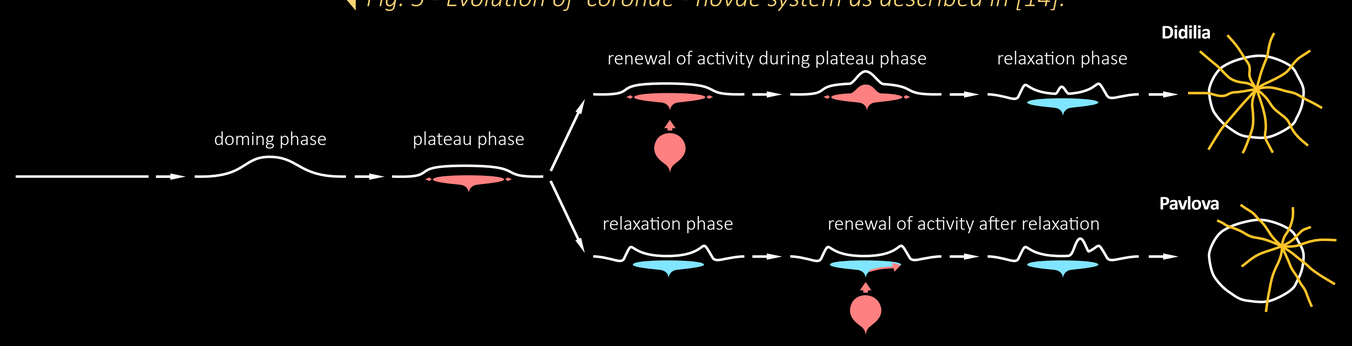
Fig. 4 - Topographic and emissivity profiles of Didilia and Pavlova coronae.



5. Didilia & Pavlova: Coronae-Novae system

The different magnitudes of decrease detected between the highest ridges and the radially fractured domes in Pavlova and Didilia coronae (Fig. 4) may indicate different degree of weathering, and hence different age between the two parts of the coronae. Indeed, the materials composing the ridges and the extensive flows are originated at an early stage of the coronae evolution (during the doming and plateau phases), while the domes (or novae) are formed at a later stage, probably after the annulus formation [12,13], as illustrated in Fig.5 [14].

Fig. 5 - Evolution of coronae - novae system as described in [14].



Key Findings

- Different patterns of emissivity variations ➡ Diverse mineralogy
- Pavlova and Didilia may have experienced a recent reactivation (young novae)
- Geographic distribution

References

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