Introduction: The structurally deformed Venus tessera terrain covers about ~8% of the surface of Venus and consistently appears locally and perhaps even globally [1] as the stratigraphically oldest material on a planet with an average surface crater retention age of ~300 - 800 Ma [2]. Thus, the tesserae provide the best and perhaps only chance to access rocks that are derived from the first ~80% of the history of Venus.

Neither the mineralogy nor the chemistry of tessera terrain has yet been measured, but Venus Express VIRTIS data show that Alpha and Cocomana tesserae have lower ~1 μm thermal emission than plains units of the same elevation [3], consistent with them having more iron-poor, felsic, compositions than the presumably basaltic plains [e.g., 4]. The formation of felsic continental crust on Earth is facilitated by the introduction of water-rich sediments into the mantle via subduction [e.g., 5]. Felsic tessera could therefore record an extinct plate tectonic regime on a water-rich planet.

Can we assess tessera composition in other ways? Recent work by Treiman et al. [6] recognized that the radar reflectivity of Venus mountaintops differs between Ovda tessera and Maxwell Montes, suggesting different surface materials. Pioneer Venus and Magellan data show that many high elevations on Venus have distinctly elevated values of radar reflectivity [7] and thus low values of radar emissivity [8]. These changes are ascribed to a chemical weathering reaction between the rocks and the local atmosphere, producing a high dielectric mineral [9-11 but see 12], where it is likely that these reactions are facilitated by the lower temperatures at higher elevations. The emissivity values then, contain information about rock composition atmospheric composition and reaction time, or surface age.

In this work, we measure and compare the radar emissivity of tessera terrain to understand the variety of emissivity signatures.

Data: Using a map of tesserae provided by M. Ivanov, we have identified the 40 largest tessera occurrences on Venus (which excludes Maxwell and other mountains). For each, we have derived altimetry from the Magellan GTDR and emissivity from the GEDR.

Results: The emissivity values for the tesserae at low altitudes are generally ~0.8 – 0.9 (we take 0.87 as a reference average), although the spread of values varies, for example, at an elevation of 6051 km, Itzpopatol tessera varies from 0.84-0.85, while Alpha has a broad range from 0.79-0.91. These values remain essentially steady up to elevations of 6052 km. With increasing elevation, the emissivity values begin to decrease in a specific number of ways we describe as “trends” (Fig. 1).

![Emissivity values for individual tesserae. Locations can be found in Fig. 2](image)

**Ovda trends.** The emissivity values for these tesserae begin to decrease at 6052 and continue until they reach the plateau's highest elevation. For Ovda Regio, this continues to a low emissivity value of 0.29 at 6054.6 km, above this, the emissivity abruptly returns to high values (~0.8) at ~6056 km (Fig. 1). This behavior is well-documented by previous studies [6, 9, 13].

The shape of the Ovda emissivity-elevation trend is mimicked by other tesserae. Thetis Regio reaches similarly low (0.30) values at 6054.1 km and is identical to Ovda. However, Manatum tessera only reaches an emissivity value of 0.52 at 6054.2 km. Sudenitsa tessera reaches a low of 0.56 at 6055.0 km before returning to higher emissivity near 6056 km. Four other tesserae: Zirka, Haasttse-baad, Chimon-mana and Alpha reach emissivity lows of ~0.75 at elevations ~6053 km. The pattern of these trends is similar, but the magnitude of the excursions differ.

**Low elevation trend.** Two sets of tesserae have low emissivity excursions below 6053 km: Doyla and Ndelya tessera reach values of 0.70 and 0.75, respectively, and Salus and Gbadu have nearly identical patterns reaching a lows of 0.75-0.76. Although we cannot see high elevation data for these tesserae, the pattern (slope) of the emissivity excursion is similar to that of Ovda but the peak elevation for the emissivity excursion is lower.

**Fortuna trend.** The tesserae in this category do not change emissivity until altitudes >6054 km and then
only slightly. Fortuna reaches a emissivity low of 0.79 at 6056 km, Itzpatapotl a low of 0.76 at 6057, a small tessera in Lakshmi reaches a low of 0.78 at 6055 and Clotho does not vary. This behavior is entirely different than Ovda and requires the presence of a different high dielectric mineral. This trend is also mimicked by the mountains Maxwell, Akna, Danu and Freya [6, 9] and the volcanoes Colette Patera and Sacajawea Patera [14].

**Discussion and Conclusions:** We measured the pattern of emissivity and elevation for 40 tesserae on Venus. Sixteen of the 40 show a decrease in emissivity at elevations > 6052. Eight have a trend like Ovda, which has an emissivity pattern (gradual decrease of emissivity and sharp return to high emissivity with altitude) we interpret as did [10, 6] to be indicative of the presence of a ferroelectric mineral. The low emissivity excursion at ~6054 corresponds to a Curie temp of 719 K [15]. This pattern is present in tessera in Aphrodite, Beta and Phoebe Regio, requiring that this ferroelectric is widespread. We relate differences magnitude of this excursion to differences in the volume of the ferroelectric [10]. That there is a difference between Ovda and adjoining Manatum and Thetis and adjoining Haasttsebaad suggests that the weathering process has been lessened by a lower volume and/or exposure of the reactants that form the ferroelectric mineral, or a younger age for these tessera surfaces, where the reaction has not had time to go to completion.

The lower elevation trend tesserae have an emissivity excursion at ~6052 km, coinciding with a Curie temperature of 735 K if due to ferroelectric minerals. This suggests that these tesserae in Aphrodite and Phoebe have a slightly different mineralogy than the Ovda class due to rock type and/or local atmospheric conditions.

The Fortuna group is fundamentally different. The elevation trend overlaps that of Maxwell which has been interpreted to be consistent with the presence of a semiconductor material there not seen in Ovda [6]. Treiman et al. [6] further posit this difference can be attributed to differences in rock type or atmosphere. That all of the materials in the Ithar region: tesserae, mountains and volcanoes [14] have similar emissivity patterns requires that this reaction is common to this location on the planet. Are the rocks of the volcanoes in Ithar unique amongst the volcanoes? Does the composition of the atmosphere in the northern latitudes differ than the mid latitudes over a time scale to produce semiconductor materials?


![Figure 2. Classification of the emissivity characteristics of Venus tesserae.](image-url)