Snowline Elevations and Discordance of Elevation & Reflectance on Venus' Maxwell Montes

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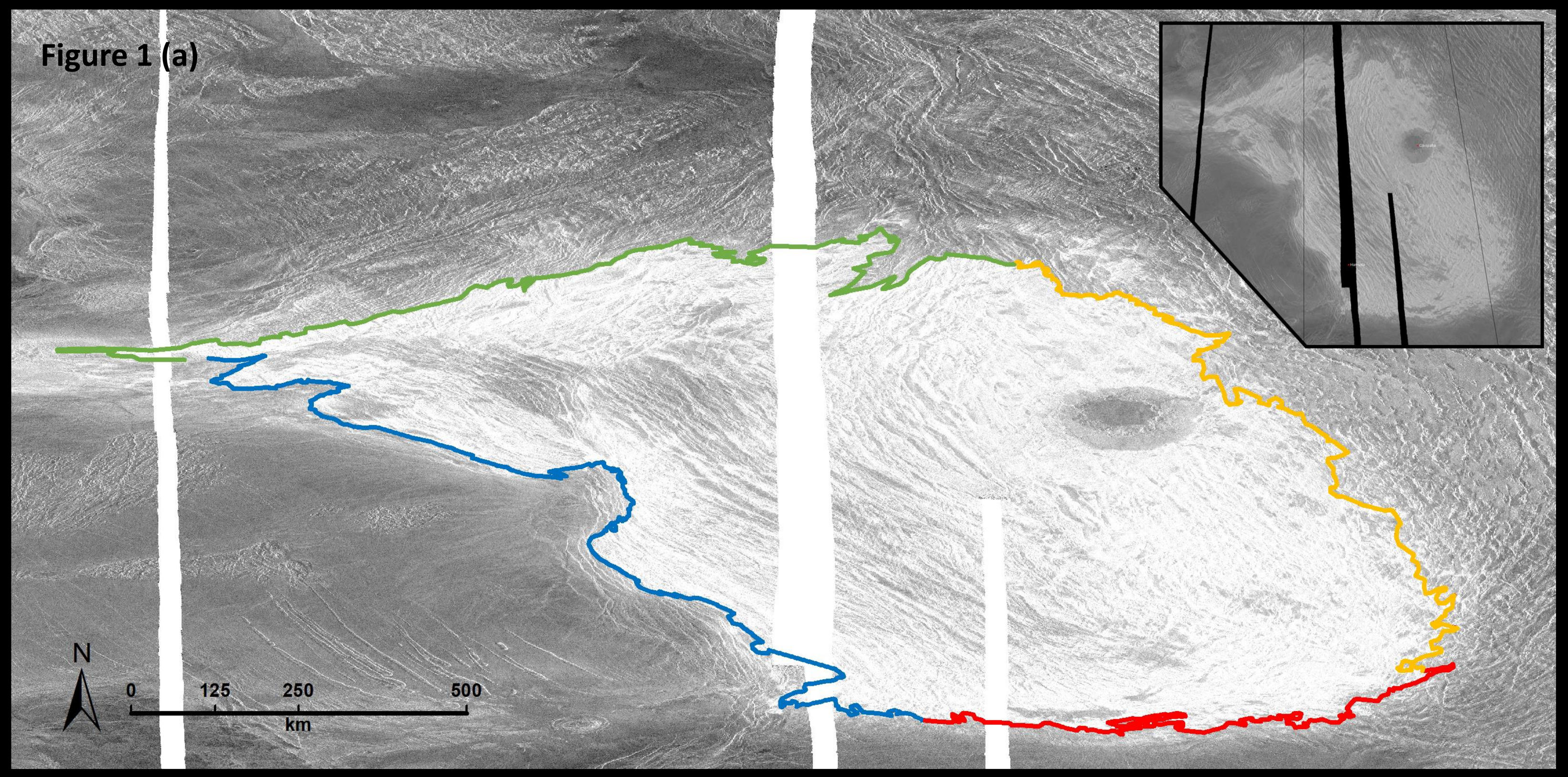


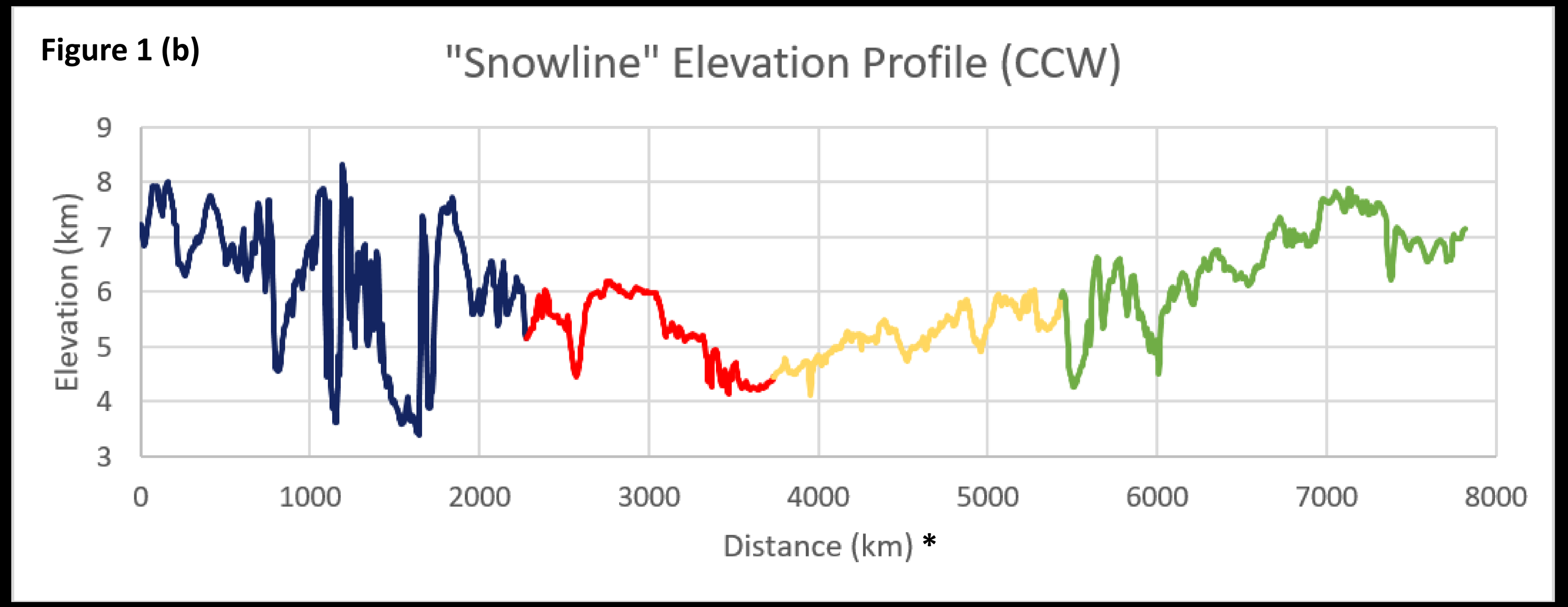


*Figure 1 (a) Left-look SAR image of general study area on Maxwell Montes. Each colored line segment has a corresponding section in profile graph (b). (b) Profile graph of the snowline on Maxwell Montes. Elevation is plotted against distance. *Distances in ArcMap are about twice the actual distance [applies to Figs 1 & 3].*

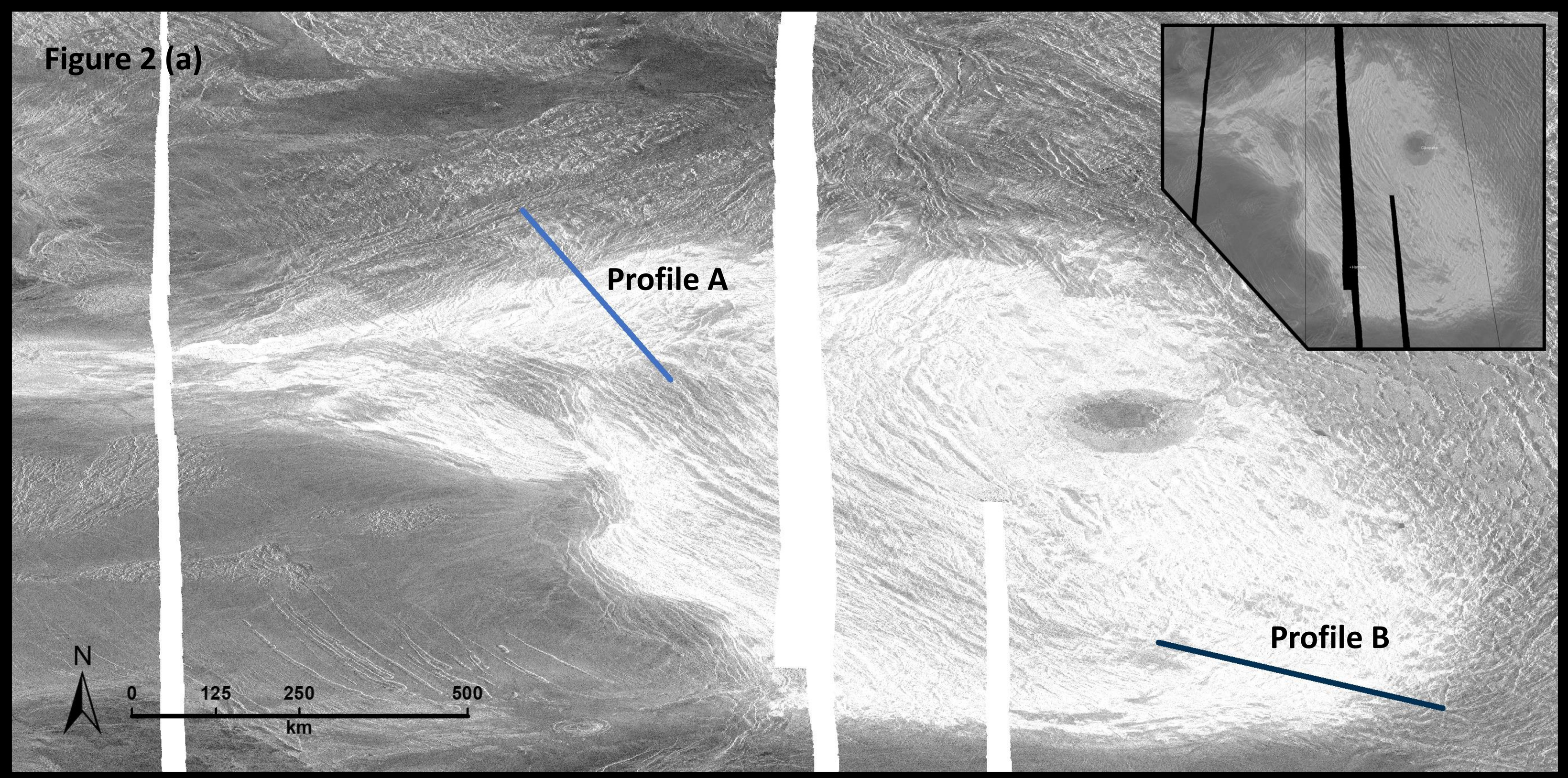
Introduction

SAR imagery from the Magellan mission (1990-1994) revealed a striking difference in radar properties on Maxwell Montes, Venus's highest elevations, compared to the rest of the planet. Maxwell's highlands have an anomalously high backscatter and abruptly drop in the lowlands. The boundary between the high and low backscatter occurs at ~4.5 km in elevation, and it is referred to as a "snowline" [1-3]. Of the many hypothesis that debate the cause of the snowline, the two most popular hypotheses are: a) compounds from the atmosphere interact with the rocks to form radar-reflective minerals (pyrite, magnetite, etc.), or b) metallic frosts (Te, or chalcogenides with Pb, Bi, etc.) precipitate from the atmosphere and increase the reflectivity of the rocks [4-10].

<u>We test these hypotheses by analyzing the spatial arrangement of the changes in radar properties</u>.

Methodology

We used SAR left-look imagery (spatial resolution as great as 75 m per pixel), Fresnel reflectivity, emissivity, and altimetry, from the Magellan spacecraft mission (1990-1994) [11].



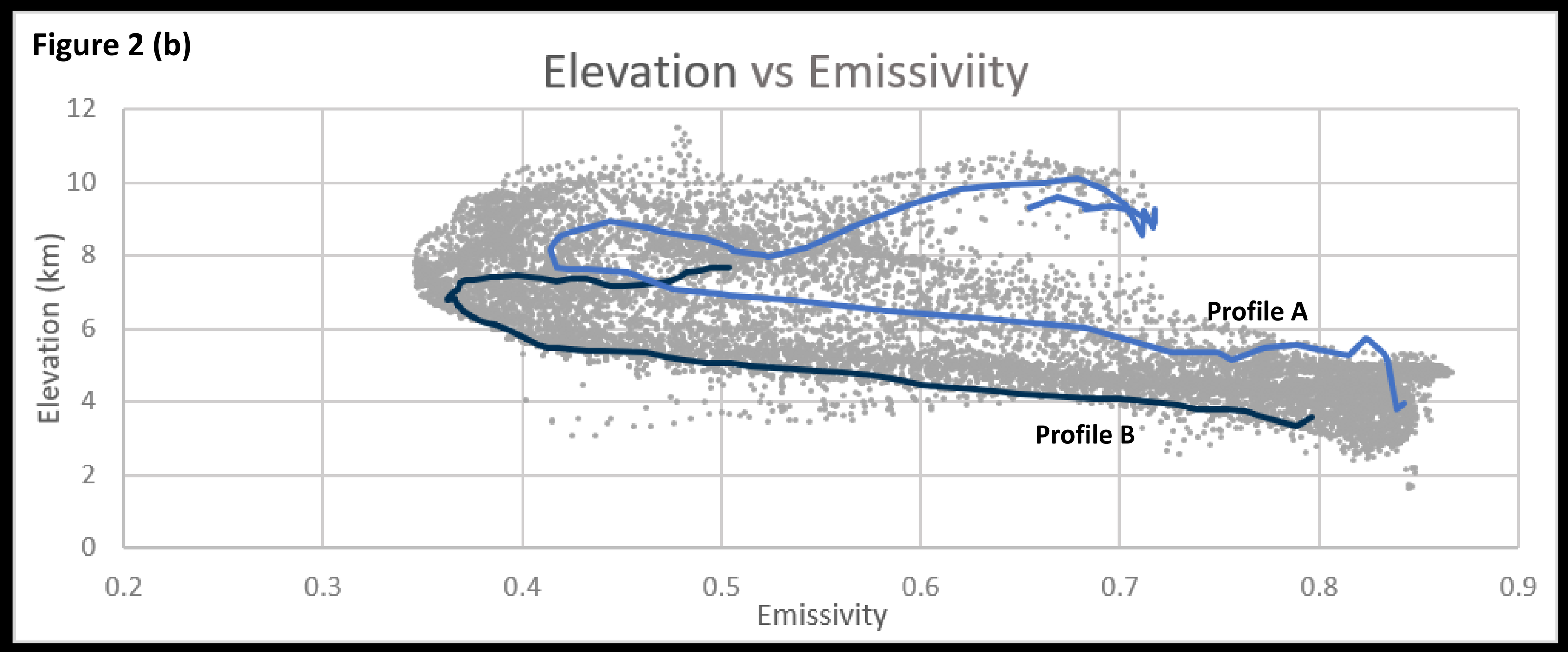


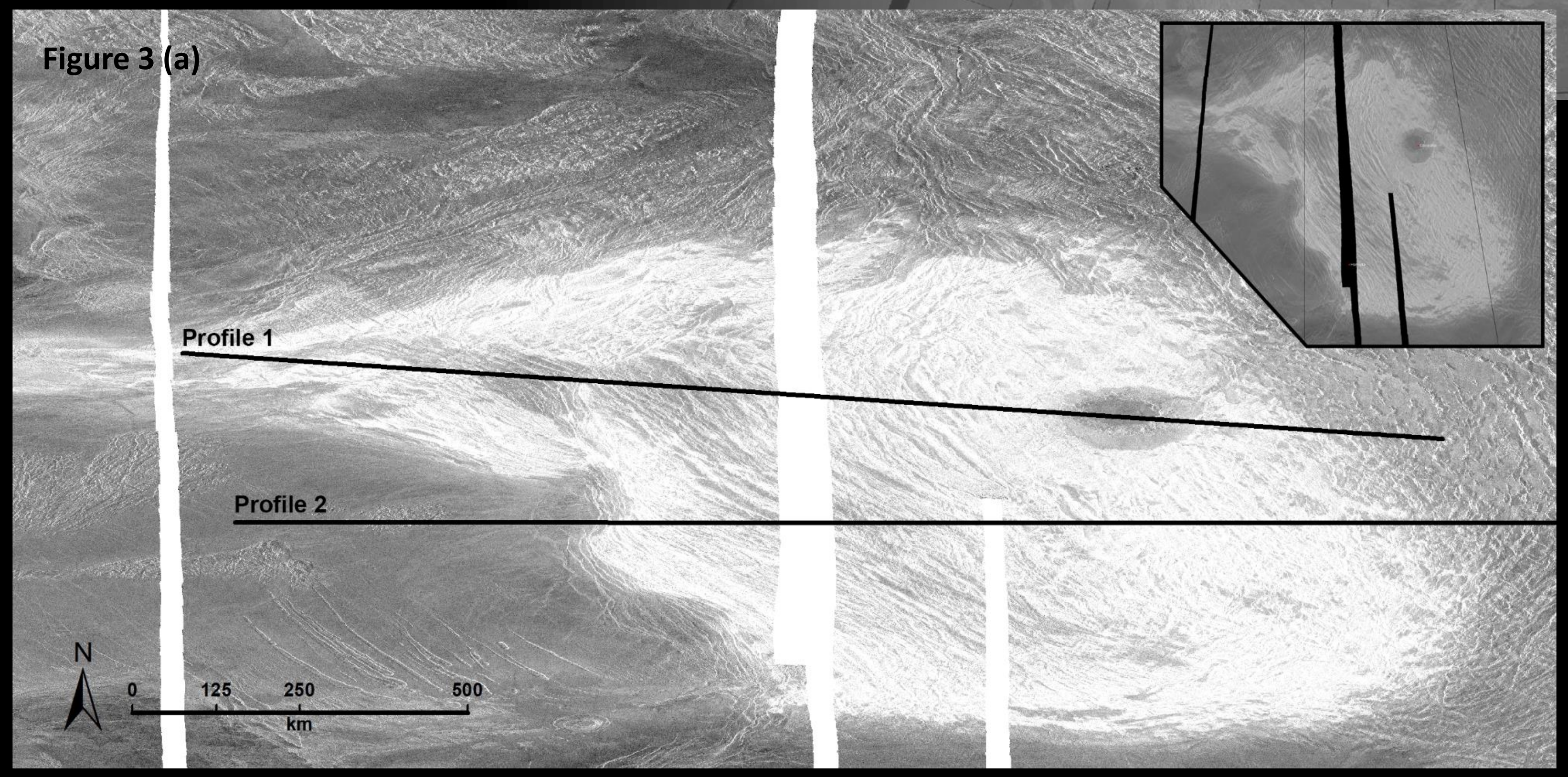
Figure 2 (a) Map of profile lines A and B. (b) Profile graphs of elevation against emissivity is a recreation of a figure by [2] of Maxwell Montes' emissivity signature. Overlain are profile lines A and B to demonstrate the differences in emissivity values in the northern and southern regions of Maxwell.

Results & Implications

In Figure 1, we traced the perimeter of the snowline and a plotted the relationship between the snowline edge and elevation. Figure 2 is a recreation of Maxwell's emissivity signature by [2], overlain with 2 profile lines to show the spatial variation and trends regarding elevation. The general trend is that the snowline is at a higher elevation (~8 km) in the NW region, and gradually decreases approaching the SW (~4.3 km).

<u>These results have 3 implications:</u> 1) If the snowline is an isotherm, we estimate that the temperatures are ~30 K higher on northern Maxwell by using the mean laps rate of ~7.7 K/km [12]; 2) If the snowline is an atmospheric precipitate, we interpret the snowline at higher elevations (NW) as a 'snow shadow'. This implies the presence of a S or SE wind current, supported by general circulation models [13]; 3) The snowline could represent different rock types if it is caused by a chemical reaction between the rocks and atmosphere. Snow shadow idea is still applicable.

Figure 3 shows the discordance between elevation and reflectance across Maxwell Montes. Reflectance and emissivity are expected to have an inverse relationship across an area, and reflectance should increase



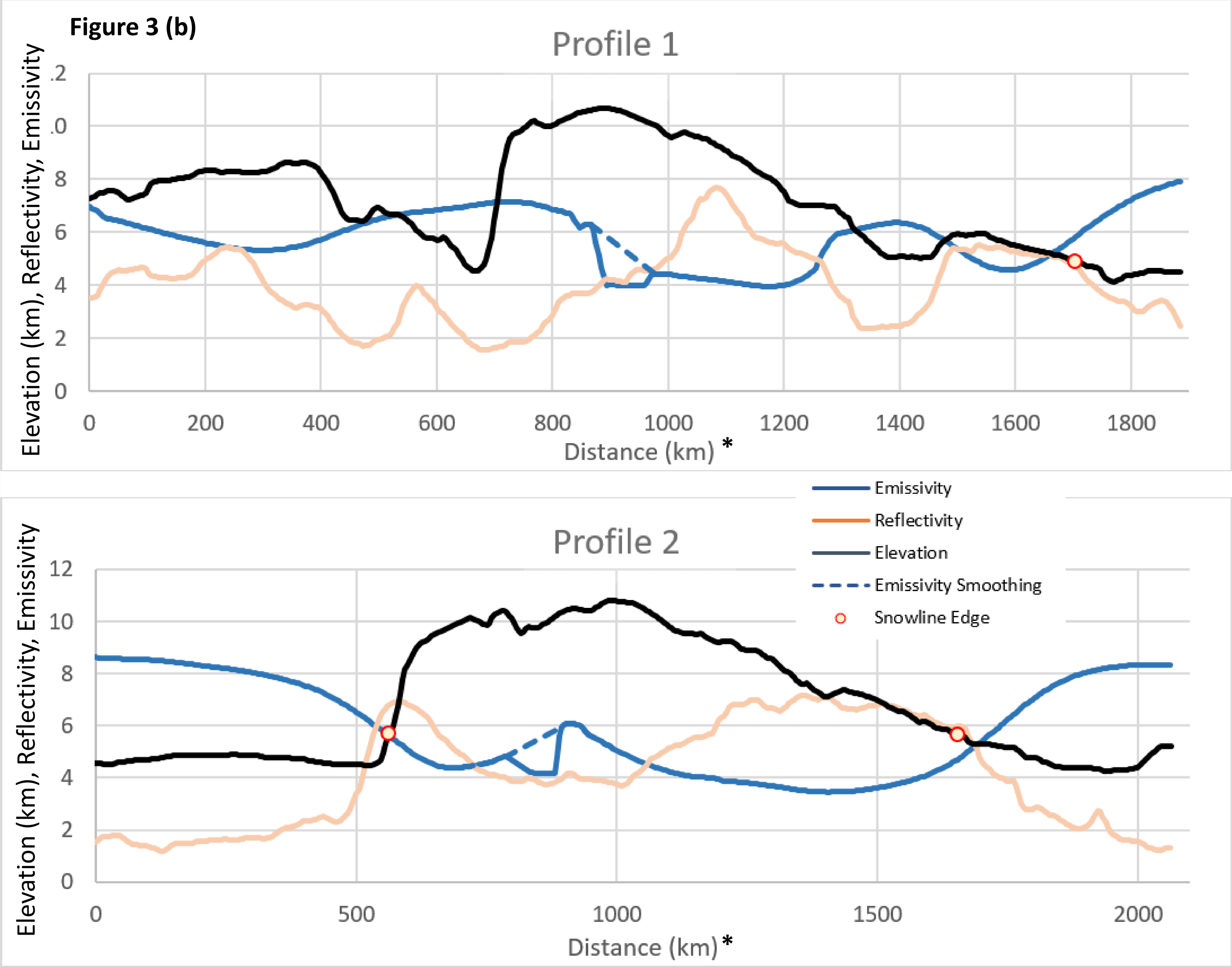


*Figure 3 (a) Map of profile lines 1 and 2. (b) Profile graphs of emissivity, reflectivity, and elevation plotted against distance. Emissivity and reflectivity values are scaled such that Emissivity = (actual value*10 000)+1 and Reflectivity = ((actual value*200)+1)*50. Equations are from Astrogeology USGS [14].*

with elevation. However, on Maxwell we see that the reflectance significantly drops at the highest elevations, starting at about ~7 km high. These results suggest a lack of semiconductors in the rocks.

References

References are same as the published abstract.
[14] Astrogeology USGS: https://astrogeology.usgs.gov/search?pmi-target=venus