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VERITAS (Venus Emissivity, Radio Science, InSAR, Topography And Spectroscopy): A Proposed Discovery Mission

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Abstract

VERITAS addresses one of the most fundamental questions in rocky planetary evolution: why did these twin planets diverged down different evolutionary paths? Venus may hold lessons for past and future Earth. Venus' hot lithosphere may be a good analog for early Earth, and could be responsible for the apparent lack of plate tectonic [1]. Determining the factors that lead to the initiation of plate tectonics would inform our predictions for rocky Earth-sized exoplanets. VERITAS answers key questions about Venus' geologic evolution, determine what processes are currently active, and search for evidence for past or present water. VERITAS would launch in 2026.

1. Introduction

VERITAS addresses one of the most fundamental questions in rocky planetary evolution: why did these twin planets diverged down different evolutionary paths? Venus may hold lessons for past and future Earth. Venus' hot lithosphere may be a good analog for early Earth, and could be responsible for the apparent lack of plate tectonic [1]. Determining the factors that lead to the initiation of plate tectonics would inform our predictions for rocky Earth-sized exoplanets. VERITAS answers key questions about Venus' geologic evolution, determine what processes are currently active, and search for evidence for past or present.

2. Payload

The VISAR X-band [2] measurements include: 1) a global digital elevation model (DEM) with 250 m postings, 5 m height accuracy, 2) Synthetic aperture radar (SAR) imaging at 30 m horizontal resolution globally, 3) SAR imaging at 15 m resolution for targeted areas, and 4) surface deformation from RPI at 2 mm precision for targeted, potentially active areas.

VEM [3,4] will produce surface coverage of most of the surface in 6 NIR bands located within 5 atmospheric windows and of 8 atmospheric bands for calibration and water vapor measurements.

VERITAS will use Ka-band uplink and downlink to create a global gravity field with 3 mgal accuracy / 145 km resolution (130 spherical harmonic degree and order or d&o) and providing a significantly higher resolution field with much more uniform resolution than that available from Magellan.

3. Science

3.1 Geologic Evolution

VERITAS answers key science questions via: 1) examining the origin of tesserae plateaus -possible continent-like features, 2) assessing the history of volcanism and how it has shaped Venus' young surface, 3) looking for evidence of prior features buried by volcanism, and 4) determining the links between interior convection and surface geology. In particular, VERITAS will examine the stratigraphy and nature of tesserae deformation features, determine the processes modifying impact craters, search for evidence of pre-existing features such as buried impact basins, and determine the origin of tectonic features such as huge arcuate troughs that have been compared to Earth's subduction zones.

Magellan spherical harmonic gravity field has an average resolution of only 550 km [5], which is too low to determine elastic thickness [6]. VERITAS data, with an average resolution of 165 km, will enable estimation of elastic thickness (a proxy for thermal gradient) and resolution of specific geologic processes [7].

3.2 Water and Igneous Rock Type

VERITAS looks for the chemical fingerprint of past water in the form of low Fe, high Si rock in the tessera plateaus [8] and larger tesserae inliers, and for present day volcanic outgassing of volatiles in the form of near surface water variability associated with recent or active volcanism.

3.3 Current Activity

Several studies have found evidence of current or recent volcanism on Venus. [e.g. 9]. VERITAS uses a variety of approaches to search for present day activity, including 1) tectonic and cm-scale volcanic surface deformation, 2) chemical weathering, 3) thermal emission from recent or active volcanism, 4) topographic or surface roughness changes, and 5) comparisons to past mission data sets.

4. Summary and Conclusions

VERITAS will create a rich data set of high resolution topography, imaging, spectroscopy, and gravity. These co-registered data will be on par with those acquired for Mercury, Mars and the Moon that have revolutionized our understanding of these bodies. In addition to answering fundamental science questions, VERITAS' data would motivate further Venus missions. Global topography is needed to enable both clutter removal for subsurface sounding, and as part of the data reduction for VEM at tessera. Active surface deformation would promote a seismic mission. Accurate topography plus surface rock type would optimize targeting of surface or areal missions.

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