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Exploring Emissivity Variations of Venus Analogs Under Simulated Surface Conditions: Insights for VEM and VenSpec-M data Analysis

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Surface rocks on Venus are exposed to a dense atmosphere, primarily composed of CO_2 (96.5%) and N_2 (3.5%), with trace amounts of H_2O and sulfur compounds like SO_2 and H_2SO_4, surface temperatures around 460°C and pressures □ 90 times that of Earth. Understanding surface-atmosphere interactions is essential for interpreting data from NASA VERITAS and DAVINCI and ESA EnVision mission. Collaborative research between the Planetary Spectroscopy Laboratory (PSL) at DLR and the Hot Environments Laboratory (HEL) at NASA GSFC compares the emissivity responses of altered and unaltered Venus surface analogs within the 1 µm spectral region. This spectral range is significant as it corresponds to atmospheric windows in Venus' thick cloud cover, enabling remote sensing of the surface. Instruments like the Venus Emissivity Mapper (VEM) on VERITAS, VenSpec-M on EnVision, and the DAVINCI VISOR camera observe Venus in this region, requiring emissivity measurements under Venus-like conditions [1–4].

Methodology and Samples: This study selected well-characterized basalt and granite samples as Venus analogs. Here we focus on Saddleback basalt sanples from the Mojave Desert [5] prepared as slabs and granular materials of various sizes. Laboratory analyses included:

- Hemispherical reflectance measurements at ambient temperature in the near-infrared spectral range.
- High-temperature emissivity measurements under Venus-like conditions (400–480°C).
- Weathering experiments exposing samples to a simulated Venusian atmosphere in the Small Venus Chamber (Lil’ VICI) at HEL.

- Chemical analyses using micro X-ray fluorescence (µXRF) and scanning electron microscopy (SEM) for unaltered, heated, and altered samples at the Museum für Naturkunde (MfN, Berlin).

Fine granular samples, used to maximize interaction with atmospheric gases, are unlikely on Venus due to the absence of water-driven processes required for their formation [6,7]. Emissivity measurements captured NIR emissivity changes due to heating and alteration after weathering in Lil' VICI [8]. Hemispherical reflectance measurements served as references for calibrating emissivity data.

Findings and Implications: Altered basalt samples displayed increased emissivity in the NIR range, partly due to "soot" from chemical reactions between chamber walls and SO_2 gas [9] and possibly darkening from mineral and glass breakdown at high temperatures. Comparisons between slab and granular morphologies highlighted the importance of studying various sample types to understand weathering effects comprehensively.
Future experiments will involve basaltic and granitic samples subjected to extended weathering durations and varied conditions, including comparative analyses between HEL and Glenn Extreme Environments Rig (GEER) experiments.These efforts aim to refine the understanding of weathering effects and improve data interpretation from Venus missions.

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