In situ NIR imaging of different types of lava flow in Iceland as an analog to Venus – in the spectral range of VEM/VERITAS

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The composition of the lava on Venus and its alteration state is poorly understood. The Venus Emissivity Mapper (VEM) (Helbert et al., 2022) will observe the surface of Venus in the NIR range through five atmospheric windows covered by six spectral bands. These will allow studying the spectral characteristics of the Venusian surface, as well as the type of lava and likely alteration processes. Both the NASA VERITAS (Venus Emissivity, Radio Science, InSAR, Topography, and Spectroscopy) mission and the ESA EnVision missions will carry a VEM-like instrument. To prepare for these missions and deepen our understanding of the emissivity spectral characterisation of various volcanic rocks, we (1) conduct field work at Venus analogue sites in oder to collect samples, (2) develop an emulator to the VEM, aka. VEMulator, which allows in situ measurements in the spectral range of the VEM instrument, (3) use the Venus chamber at the Planetary Spectroscopy Laboratory (PSL) at DLR-Berlin, to obtain emissivity spectra of the samples at Venus temperatures (Helbert et al., 2022).

VERITAS organized a field campaign in Iceland (Nunes et al., 2023). This campaign included DLR airborne radar (SAR) data collection in x-band, like VERITAS and s-band, like Magellan and EnVision. The team also collected surface roughness and permittivity as ground truthing for the airborne SAR data, and in-situ NIR data acquisition using the VEMulator 2.0. The VEMulator covers a comparable spectral range to the six mineralogy VEM spectral channels. An earlier version of this set-up has already been successfully used in a field campaign in Vulcano, south of Italy (Adeli et al., 2023a).

To achieve the above-mentioned goals, we have focused on the Fagradalsfjall volcanic complex, as an analog site to Venus (Adeli et al., 2023b). This is an area of faults and fissure swarms, with recent and frequent volcanic activity in 2021, 2022, and 2023. The lack of vegetation and atmospheric alteration of the new lava flows, makes this site a prime Venus analog to Venus. Our goals have been to image the young basaltic lava fields, to image the fresh fumaroles and their deposits on the basaltic lava field, to image the superficially oxidized layers due to the hot gases (e.g., water), to image the hot lava surface (approximately 200-480°c) of the active vent of Litli-Hrútur (eruption terminated 2 days prior to our arrival) to obtain in situ emittance of the basaltic rock at Venus temperature. All this collected data will provide detailed spectral information and a deeper understanding of the surface composition of the studied lava flows. By comparing the field and laboratory datasets, we can assess the capabilities of the VEM instrument in distinguishing lava types, compositions, and Fe-content. This work will lay a foundation for the detailed interpretation of spectra from Venus and is vital preparation for the scientific goals of the NASA VERITAS and ESA EnVision missions.

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References

Helbert, J., et al., 2022, The new Venus spectral facility at the DLR Planetary Spectroscopy Laboratory to support the ESA EnVision and NASA DACINCI and VERITAS missions, IR Remote Sensing & Instr., SPIE, https://doi.org/10.1117/12.2676635 .

Nunes D.C., et al., 2023, Seeking Venus on Earth: The VERITAS/DLR analog field campaign, LPSC.

Adeli et al., 2023a, Designing iterations of the Venus Emissivity Mapper Emulator: making a space instrument suitable for field campaigns, IR Remote Sensing & Instr., SPIE, https://doi.org/10.1117/12.2677369 .

Adeli et al., 2023b, Reykjanes Peninsula, Iceland, as an analog site for Venus; Remote sensing investigation and planned field work to support VERITAS mission, LPSC. Abstract 2693.