EPSC Abstracts
Vol. 17, EPSC2024-918, 2024, updated on 17 Dec 2024
https://doi.org/10.5194/epsc2024-918
Europlanet Science Congress 2024


# Near-Infrared Data Acquisition for the VERITAS 2023 Iceland Field Campaign

**Solmaz Adeli**[1], Stephen Garland[1], Daniel Nunes[2], Sue Smrekar[2], Nils Mueller[3], Akin Domac[1,4], Giulia Alemanno[1], Christopher Hamilton[5], Gro Pedersen[6], Gael Cascioli[7,8], Christian Althaus[1], Ernst Hauber[1], Frank Trauthan[1], Oceane Barraud[1], Dennis Wendler[9], Rana Demirok[1,3], Shreya Chauhan[1,3], Joern Helbert[1], and the The VERITAS Science Team[*]

[1]Deutsches Zentrum fuer Luft- und Raumfahrt (DLR), Institute of Planetary Research, Berlin, Germany (solmaz.adeli@dlr.de)
[2]Jet Propulsion Laboratory, California Inst. of Technology, CA, USA
[3]Freie Universität Berlin, Germany
[4]Inst. of Earth and Env. Sci., Albert-Ludwigs-Universität Freiburg, Germany
[5]Lunar and Planetary Lab., Univ. Arizona, USA
[6]Nordic Volcanological Center, Inst. of Earth Sci., Univ. of Iceland, Reykjavík, Iceland
[7]Univ. of Maryland Baltimore County
[8]NASA Goddard Space Flight Center
[9]Inst. of Optical Sensor Systems, German Aerospace Center (DLR), Berlin, Germany
[*]A full list of authors appears at the end of the abstract

**Introduction:** The composition of lava fields on Venus and their alteration state are poorly constrained. The Venus Emissivity Mapper (VEM) [1, 2] on board NASA's VERITAS [3] and its twin VenSpec-M on ESA's EnVision will observe the surface of Venus in the NIR range through five atmospheric windows covered by six spectral bands (0.86 to 1.2 µm). These will enable studying the spectral characteristics of the Venusian surface, as well as lava types and possible alteration processes. To prepare for these missions and deepen our understanding of the emissivity spectral characterization of various volcanic rocks, we developed a field camera system analogous to VEM, named "VEMulator2.0" [4], and have undertaken in-situ measurements during the VERITAS expedition in Iceland, early August 2023. We relate these data to emissivity spectra of field samples acquired in the Venus chamber at the Planetary Spectroscopy Laboratory (PSL) of DLR-Berlin [1].

**Iceland:** The vegetation-free, geologically recent basaltic lava fields of Iceland make this area a prime Venus analog [5, 6]. Selected regions of interest for this campaign are [6]: Askja/Holuhraun in the highlands; Fagradalsfjall on the Reykjanes Peninsula. These ROIs offer a wide variety of surface textures, sand cover, and diverse fumarolic deposits, as well as macro- and micro- fractures. Fagadalsfjall is of particular interest for NIR team because of its very fresh lava flows (2021, 2022, and 2023), the still-cooling lava in the subsurface, and the recent fumarolic alteration products on the surface.

**In-situ NIR data acquisition:** The VEMulator2.0 is an in-house built camera system equipped with an InGaAs detector – similar to the VEM flight model – and a filter wheel with six bandpass filters: 860, 910, 990, 1030, 1100, 1200 nm. A simpler version of this set-up had been successfully used in a field campaign in Vulcano, Italy [7]. In Iceland, data were collected in daytime (reflected sunlight) and at nighttime as emittance of the very hot (~100-480°C) lava flow at the active fissure of Litli-Hrutur.

*Reflectance data.* The main goal here is to understand the NIR spectral response of different basaltic surfaces in the spectral range of VEM. The sites were selected based on their surface texture and mineralogy. The goal was to image varying surface textures as well as contacts between different materials, such as sand cover over the 2014-2015 Holuhraun lava field, fumaroles and their deposits of Holuhhraun and Fagradalsfjall, tephra mantled lava flows near Askja, very fresh surfaces of Fagradalsfjall's 2021-2023 fields, and near surface alteration due to escaping hot gases (including water vapor), exposed via fractures.

The imaged sites were scanned by the LiDAR team to obtain a high-resolution (millimeter-scale) DEM of the ROIs. These data will constrain surface geometry [8, 9]. GPS coordinates of the VEMulator location and the imaged targets have been collected, providing cm-scale precision on the camera-target distance. Two calibration targets were used in each imaged scene: one black surface as blackbody, and a gray disc. Both calibration targets were spectrally analyzed in the PSL laboratory before and after the field campaign, thus have known spectra that will help improving our data calibration processes.

*Emittance data.* The main goal here was to collect in-situ emittance of a fresh lava flow in the NIR spectral range of VEM. We imaged the hot lava surface (approximately 100-480°C) of the active vent of Litli-Hrútur where an eruption terminated two days prior to our arrival to obtain in-situ emittance of the basaltic rock at Venus temperature, after sunset. We used a FLIR thermal camera to find the hot spots, in collaboration with colleagues at the Univ. of Iceland. This allowed direct observation of surface temperature and identification of several cracks where hot gases were escaping from the cooling lava. All these collected data will provide detailed spectral information and a deeper understanding of the surface composition of the studied lava flows.

*Sample collection.* We collected samples from every imaged scenery by VEMulator. A total of ~60 kg of samples was transported to DLR in Berlin for post- processing and analyses using reflectance and emittance methods available there. All the samples are carefully labeled and stored in the sample collection laboratory at DLR-Berlin.

**Laboratory measurements:** Bi-directional and hemispherical reflectance spectra from 0.7-2.63 μm were collected using the Bruker Vertex 80V spectrometer at the PSL in DLR-Berlin. The data will be related to the daytime field data to better understand the NIR spectral response of surface material using the six spectral bands. We will collect emissivity measurements using the Venus chamber at PSL, to correlate with the in-situ nighttime data collected from Litli-Hrutur 2023 lava field. In addition, various Icelandic basalt samples will be analyzed in the Venus chamber with the goal to expand our datasets of emissivity spectra of Venus-analog materials as part of the VEM calibration plan [10].

**Conclusion and future work:** In the VERITAS expedition 2023 in Iceland, we collected in-situ NIR data using a Venus Emissivity Mapper (VEM) emulator (VEMulator2.0), and 60 kg of samples of Venus analog materials. The highlight of this work is the data we collected after sunset from the active fissure of Litli-Hrutur in the range of Venus surface temperature. We are currently analyzing the samples at PSL-DLR Berlin using the reflectance and emittance set-ups to correlate the laboratory data with the field data. This work will increase our understanding of emissivity of rock samples in hot temperature and will contribute in the VEM calibration plan.

**Acknowledgments:** SA, SPG, NM, AD received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 871149. GC, EM was supported by NASA Planetary Science Division Research Program through the GSFC GIFT ISFM.

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**The VERITAS Science Team**: E. Mazarico; L. Jozwiak; D. Buczkowski; J.L. Whitten; J. Head; A. Maturilli; M.D. Dyar