NIR LABORATORY MEASUREMENT OF THE VERITAS ICELAND 2023 CAMPAIGN SAMPLES.

S. Adeli[1], N. Mueller[1,2], D. Nunes[3], S.P. Garland[1], S.E. Smrekar[3], M. D. Dyar[4,5], G. Alemanno[1], A. Maturilli[1], R. Demirok[1,2], C.W. Hamilton[6], G.B.M. Pedersen[7], G. Cascioli[8], E. Mazarico[8], L. Jozwiak[9], D. Buczkowski[9], J.L. Whitten[10], J. Helbert[1], and the VERITAS Science Team. [1]Inst. of Planetary Research, German Aerospace Center (DLR), Berlin, Germany, (Solmaz.Adeli@dlr.de); [2]Freie Universität Berlin, Germany; [3]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA; [4]Mount Holyoke College, South Hadley, MA, USA, [5]Planetary Science Institute, Tucson, AZ, USA, [6]Lunar and Planetary Laboratory, Univ. Arizona, Tucson, AZ, USA; [7]Nordic Volcanological Center, Inst. of Earth Sci., Univ. of Iceland, Reykjavík, Iceland; [8]NASA Goddard Space Flight Center, Greenbelt, MD, USA; [9]John Hopkins Univ./Applied Physics Lab, Baltimore, MD, USA; [10]Tulane Univ., New Orleans, USA.

Introduction: The VERITAS 2023 Iceland analog campaign investigated the surface features of volcanic landscapes at Holuhraun, Askja and Fagradallsfjal in Iceland as analogs to Venus. The campaign consisted of an aerial component to collect multiband airborne radar data and a surface component to characterize in-situ surface properties relevant to radar. The team also acquired near-infrared (NIR) spectra in the wavelength range of the Venus Emissivity Mapper (VEM) instrument, as well as soil and rock samples. The NIR study included in-situ data acquisition using a field emulator of the Venus Emissivity Mapper (VEM) on board NASA's VERITAS and ESA's EnVision missions. The VEMulator 2.0 [1, 2, 3] aims to provide a training dataset for scientists to understand the NIR spectral response of various volcanic surfaces collected in-situ using six filters similar to those on the VEM [3]. The team also collected samples representing various geological features, compositions, and surface textures for subsequent analyses in the Planetary Spectroscopy Laboratory (PSL) of the German Aerospace Center (DLR)-Berlin. The main goal of the latter effort is to analyze spectral variations in the collected samples, in order to support the in-situ NIR data acquisition and the airborne radar investigation.

This work focuses on the spectroscopy of different particle size ranges, both on and below the surface. The radar scattering properties have some dependence on particle size distributions and on the material composition. Here we show the changes in spectra characteristics as a function of particle sizes.

Iceland as an analog to Venus: The vegetation-free, geologically recent basaltic lava fields of Iceland make this area a prime Venus analog. In the pre-field campaign study phase, we identified Askja/Holuhraun in the highlands and Fagradalsfjall on the Reykjanes Peninsula as regions of interest that offer a wide variety of surface textures, sand and fines cover, and diverse fumarolic deposits, as well as macro- and micro-fractures (for more details on the ROIs see [4]).

Surface component of the airborne radar data collection: The goal of the airborne campaign was to produce regional-scale coverage using DLR's F-SAR full-polarimetric, multi-band airborne synthetic aperture radar system [5]. The approach to the surface task was to define 5×5 m patches distributed across the ROIs for detailed measurements. Figure 1 shows one such patch. The limits of the patch are marked by bright pink coloured rocks (faintly visible in the figure 1). Sampling sites were selected carefully to represent the general patch surface grain size distribution. Samples were collected using a shovel from the surface, and the shallow subsurface, at ~20 cm depth. Surface and subsurface samples were bagged separately.

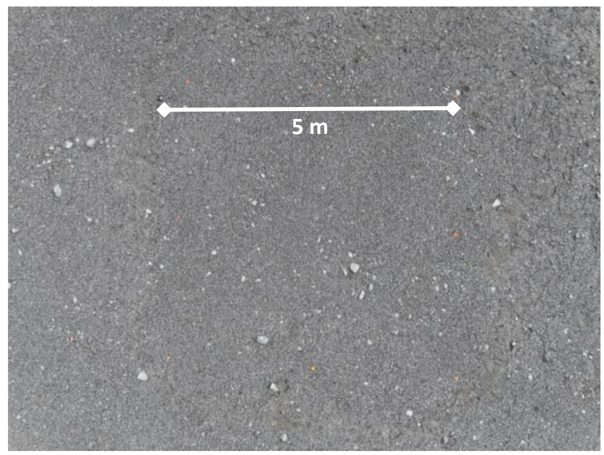

Figure 1 – Patch HLHS04 located on the sand bed, adjacent to the Holuhraun lava field termination, in approximately of seasonal fluvial activities.

Methods of sample preparation and laboratory measurements: After transport to the PSL facility at DLR-Berlin, the surface and subsurface samples were carefully sieved and divided into pre-defined grain size bins of 1-2 mm, 400 µm-1 mm, 250-400 µm, 125-250 µm, 63-125 µm, 25-63 µm, and <25 µm (Figure 2). Bi-directional reflectance spectra in the wavelength range 1-2.5 µm were collected at room temperature under vacuum using the Bruker Vertex 80V spectrometer at the PSL in DLR-Berlin. The surface samples were measured in 4 different geometry conditions where the incident angle and emission angle varied as: 0-30°, 30-70°, 45-70°, and 55-70°. The goal of varying the observation geometry is to later use these data for comparison with data collected from the VEMulator. Data plotted in Figure 3 correspond to reflectance measurment 0-30°, to be compared with RELAB dataset and other publicly available datasets. The subsurface samples were only measured using one incident and emission angle geometry of 0-30° because there are no in-situ data for comparisons.

Discussion: Despite the patch surface being macroscopically rather smooth (Figure 1) and the fines appearing homogeneous (beside the larger light-toned rocks), the finer grain size material shows spectral differences. This trend seems to be similar on the surface as well as in the subsurface.

The larger grain size groups (>250 μm) show featureless and low reflectance spectra, corresponding to the spectrum of basalt in this wavelength, whereas the group of 125-250 μm data shows an increased slope towards the higher wavelengths. The slope trend continues at finer grain sizes. This is likely caused by the higher surface-area-to-volume ratio of the finer particles, which would alter more easily in the presence of water and oxygen via oxidation of iron-bearing phases. Moreover, the finer particles scatter shorter wavelengths more effectively, leading to a relative enhancement of longer wavelengths, which is observed as reddening. In the groups of particles <125 μm, an absorption band appears at 1.9 μm that most likely corresponds to the water band – a feature unlikely to be observed on Venus.

Next steps: Ongoing work will investigate the bulk composition of these samples using XRF data. We also

Figure 2 – sorted sample from the surface of the patch in figure1, based on the grain size. Similar work has been done for the samples taken from subsurface.

plan to analyse the surface and deep samples of other patches to build a model of spectral variations as a function of grain size. Finally, we plan to correlate these findings with the airborne collected radar data.

Acknowledgments: SA, SPG, NM received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 871149. A portion of this research was conducted at the Jet Propulsion Laboratory, California Institute of Technology, under contract 80NM0020F0035 with NASA.

References: [1] Adeli, S. et al. (2024) LPSC LV, #1286 2024. [2] Garland, S. et al. (2024) Proc. SPIE 13144, XXXII, 2024 12.3028083. [3] Garland, S. et al. LPSC (2025) this meeting. [4] Nunes, D. et al., LPSC, LV, #1681 2024. [5] Horn, R. et al. (2017) 18th Intl. Radar Symp., 10.23919/IRS.2017. 8008092.

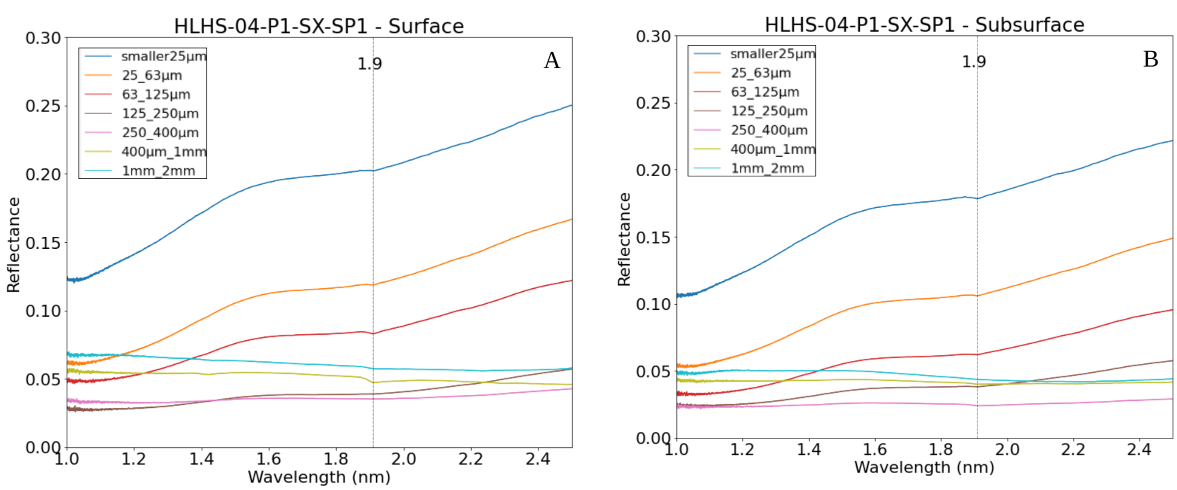

Figure 3 – Calibrated PSL reflectance spectra from the (A) surface samples and (B) subsurface samples. The samples are from the patch described in Figure. 1. Both plots have the same color scale.