VEM/VERITAS ANALOGS IN THE PSL LABORATORY IN BERLIN AND IN THE FIELD WITH THE V-EMULATOR AT VULCANO, ITALY - Preliminary Results.

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Introduction: The Aeolian Islands in south of Italy are composed of seven Islands, of which Vulcano (Fig.1) is the third largest. Tectonically-controlled magmatic activity is the source of lava for these Islands and their alignment [1]. Vulcano rocks display a diverse compositional variation from basaltic to rhyolitic [2], which makes this site an attractive analog to Venus. The island shows, in addition, a strong fumarolic activity with very high temperatures.

Investigation of this area carries out as part of the Vulcano summer school [3], which took place in June, 2022. Our main goal has been to characterize the spectra from the fresh and old volcanic rocks with different compositions, using the spectral range of the Venus Emissivity Mapper (VEM) (see [4] for more info), of the future NASA mission to Venus, VERITAS [5]. One of the main objectives of the NASA VERITAS and as well as the ESA EnVision missions is to characterize the composition and origin of the major geologic terrains on Venus. They will be able to observe the surface of Venus through five atmospheric windows with six bands. These will enable the spectral characterization of the Venusian surface, as well as deduce the type of lava and likely alteration processes, to be determined in unprecedented detail.

In-situ measurements:

V-EMulator measurements. The in-house built VEM emulator (aka V-EMulator), is composed of a commercial Raspberry PI HQ 12MP camera, containing the Sony IMX477 sensor, with a 35mm lens. The sensor is sensitive up to a wavelength of ~1000 nm. In order to improve the near-Infrared sensitivity of the camera, the infrared (IR) cut-off filter was removed. To obtain spectral information four filters with wavelength of 860, 910, 990, 1100 nm could be attached in front of the lens. These wavelengths are similar to four of the six mineralogy VEM spectral channels. For each outcrop a suite of 28 images was taken, using four filters and different gain values to obtain optimal images. Various variables were considered, including band filter, ISO value, aperture, and focus. The outcrops were chosen for variability in geological unit, morphology, composition, structure, and albedo.

Fig.2-B shows an example of the V-EMulator images, geometrically registered. The RGB image is composed of three images at 860, 910, and 1100 nm, with three different chosen gain values. The veins where high outgassing activities take place are clearly distinguishable.

Fig. 1: an overview of the Vulcano Island. All three main calderas on this island are shown. The red box indicates the study area of this work. The eruption dates are from [1].

Sampling. Various small samples (a few gr each) were collected with two objectives: 1) to allow data calibration in the laboratory, using the NIR-IR facilities in the Planetary Spectroscopy Laboratory (PSL) of DLR-Berlin, Germany [4]. For this, we collected samples from the frame imaged by V-EMulator. 2) to characterize the emissivity spectra of Vulcano's major volcanic rocks under Venus temperature conditions using the Venus emissivity chamber at PSL/DLR-Berlin. These emissivity spectra will be part of a future dataset for emissivity spectral characterization of rocks under Venus temperature condition.

Laboratory Analysis at PSL/DLR-Berlin: At the PSL/DLR in Berlin, a Venus emissivity setup allows routine measurements of VNIR emissivity spectra of Venus analogues at relevant Venus surface temperatures of 400°C, 440°C, and 480°C in a vacuum (0.7 mbar) environment (see [6]). The Venus emissivity chamber is attached to a Bruker Vertex 80V FTIR spectrometer and allows measurement of the emissivity of solid and granular samples. Samples are heated in custom-made sample cups using a very powerful induction system. Hemispherical reflectance measurements are performed in parallel for comparison with emissivity measurements on all fresh and processed samples [7].

Data calibration:

In-situ calibration. A calibration disk was used in the field, on Vulcano, in order to have a known spectrum with which to compare later laboratory spectral results.

The calibration disk is gray in color and was analyzed in the PSL/DLR laboratory before and after the field work, therefore it has a clearly known spectral characteristic. Each suite of measurements in the field, in a new location, started with one set of images taken from the cal. target. Then the measurement from the geologic outcrop of interest followed, in which the cal. target was placed on the outcrop. This ensured the accuracy of the planned calibration in the laboratory.

Calibration in the laboratory. As mentioned above, we have various samples available to us from the imaged sceneries to analyze in a wide NIR and IR spectral range (reflectance and emissivity) available at the PSL, including the cal. target and samples selected from most of the imaged outcrops. We will then compare the spectrum measured in the field with the lab data in order to better calibrate the data and gain a better insight of how to interpret the future VEM/VERITAS spectra from the surface of Venus.

Discussion and outlook:

Field work, sample collection, and laboratory measurements with both reflectance and emissivity spectroscopy methods, are the main ways to prepare for the future Venus missions: VERITAS and EnVision. Setting up a dataset of spectral characteristics of emissivity spectroscopy, and training on those data, are crucial for our interpretation of the near future data from the surface of Venus, and is the main goal of this work.

Our next steps are to finalize the calibration process; to compare the field and lab data with VIRTIS/Venus Express and Venera landers data. Also, to prepare the V-EMulator for future field works.

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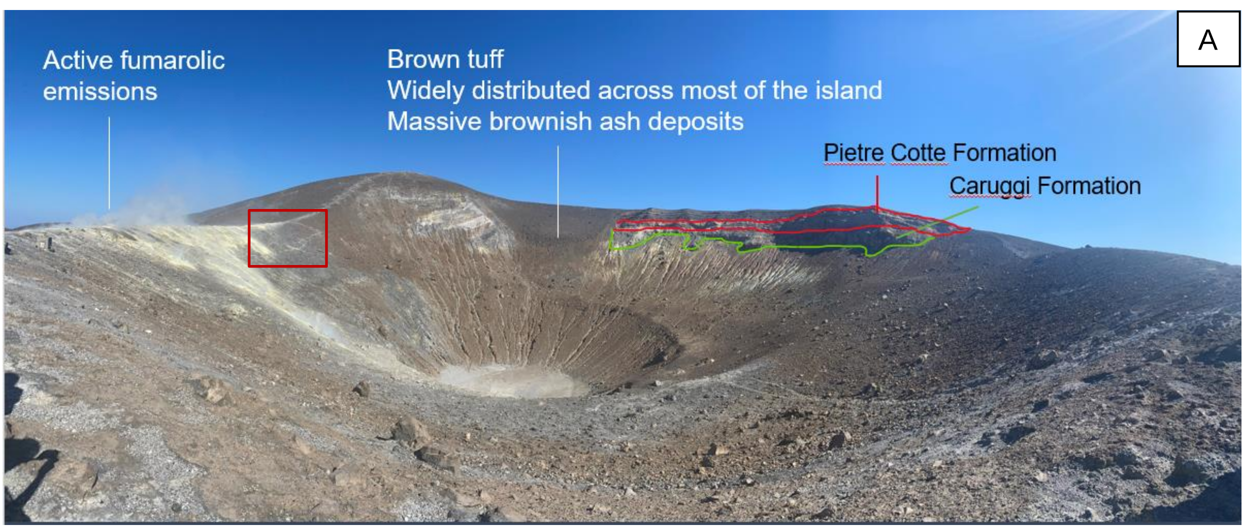

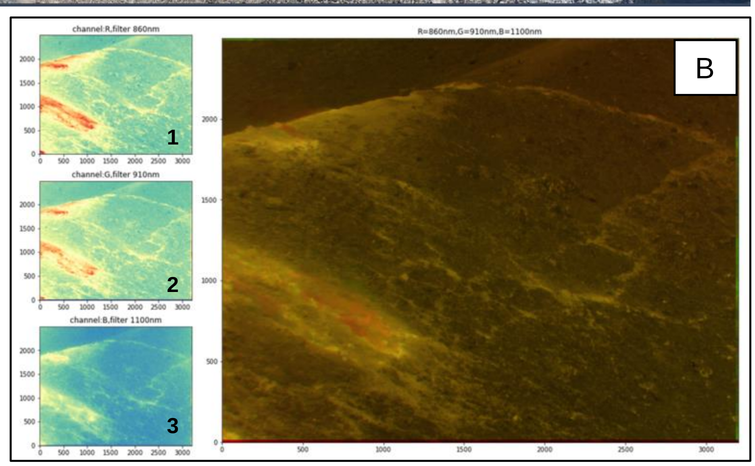

Fig 2: A) La Fossa. The main formations are shown (Formation names are from [2]. The red box indicates the location of B. B) Geometrically registered RGB image, whereas R is 860nm (1), G is 910nm (2), and B is 1100nm (3). The veins where the fumarolic activity takes place are distinguishable as yellow in color. The red color shows places with higher fumarolic activity than the yellow veins.