LABORATORY EXPERIMENTS DESIGNED TO EXPLAIN THE SPECTRAL DISTINCTNESS OF PITTED TERRAINS ON VESTA. T. Michalik[1], A. Maturilli[1], K. Otto[1], R. Jaumann[1,2] [1] German Aerospace Center (DLR e.V.), Rutherfordstr. 2, 12489 Berlin, Germany (tanja.michalik@dlr.de), [2] Freie Universität Berlin, Malteserstr. 74-100, 12249 Berlin, Germany.

Introduction: Within the ejecta blanket of Marcia crater on asteroid Vesta, pitted terrains exhibit pronounced pyroxene absorptions as well as higher reflectance at 750 nm with respect to their immediate surrounding (example Fig. 1) [1]. This spectral difference is mainly observable in the 750/917 [nm]-ratios. Denevi et al. [2] associated the pitted terrains with OH-rich darker material and explained them through explosive volatile degassing. However, a 'dark' spectral appearance is only true for the pitted terrains on the crater floor of Marcia and not for the pitted terrains outside of Marcia. In this study, we try to explain the pronounced pyroxene characteristics of those pitted terrains by conducting laboratory heating experiments in vacuum.

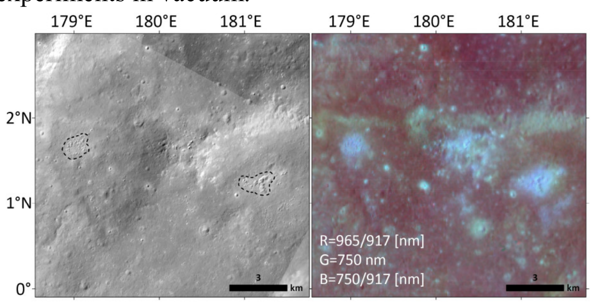

Figure 1: Two pitted terrains (black dashed lines in the left panel) in clear filter LAMO resolution (left panel) and false color ratio RGB at HAMO resolution (right panel). Dawn Framing Camera LAMO resolution is ~16 m/px, HAMO ~ 60 m/px [3].

Laboratory experiments: Our experiments were conducted in the Planetary Spectroscopy Laboratory (PSL) at the German Aerospace Center [4]. We prepared analog materials for the Vestan regolith comprising hypersthene (25-125 µm) as an endogenic Vestan analog and a Phobos simulant as an exogenic analog (containing ~60% OH-bearing serpentine) which was created on the basis of Tagish Lake, a carbonaceous chondrite [5]. Carbonaceous chondrites are thought to represent exogenic contaminants in the Vestan regolith which was observed by Dawn as 'dark material' [e.g., 6,7].

We created different mixtures of these materials and heated them under vacuum (10^{-5} bar) by means of an underlying induction plate to about 800 °C (maximum temperature varies due to partly uncontrollable current transmission). After the samples cooled down, we transferred them and measured their reflectance (Fig. 2) in an unevacuated Bruker 80V spectrometer by means of a Bruker A513 biconical reflectance unit in the wavelength range that is also covered by the Dawn Framing Camera (0.4-1 µm). We measured each sample twice on a slightly different spot to account for heterogeneities in the sample itself. The spectra were then resampled to fit the format of the Framing Camera in order to compare the values directly with Vestan data.

Figure 2 displays data of six experiments:
pure Phobos simulant, 90 wt% Phobos simulant ("90 Pho") and 10 wt% hypersthene ("10 Hyp"), 80 wt% Phobos simulant and 20 wt% hypersthene, 70 wt% Phobos simulant and 30 wt% hypersthene, 50 wt% Phobos simulant and 50 wt% hypersthene, pure hypersthene.

Experiment description: The first ejection events (probably OH-loss) for each experiment (except the pure hypersthene) were observed around 300 °C. After reaching the maximum temperature, the surfaces of the sample materials looked rugged and 1 mm to 1 cm wide pits formed. Significant ejection outside of the Ø 5 cm sample container only took place for the pure Phobos simulant.

The observed surface structures were very fragile and disintegrated upon the slightest physical interaction. No grain size segregation in any form was observed.

Reflectance measurements: The post-experimental reflectance spectra of the samples differ from what we expected. Our expectation was that due to the OH-loss during the heating process, the pyroxene characteristics would intensify and possibly their reflectance as well. As phase transitions of serpentine to olivine start at around 750 °C, we expected to observe effects of that as well. Instead, the overall reflectance as well as the pyroxene band depth decreased. For some experiments, the reflectance increased but the 750/917 [nm]-value (indicator for pyroxene band depth) still decreased.

Worth noting is also that a 50:50 mixture is still significantly reduced in reflectance (with respect to the pure hypersthene), giving the Phobos simulant the dominant role for its spectral characteristics.

Discussion: Our measurements display the opposite of what we observe for the pitted terrains on Vesta. Reasons could be the following: unsuitable analog materials, unsuitable experimental setup, different processes causing the phenomenon on Vesta.

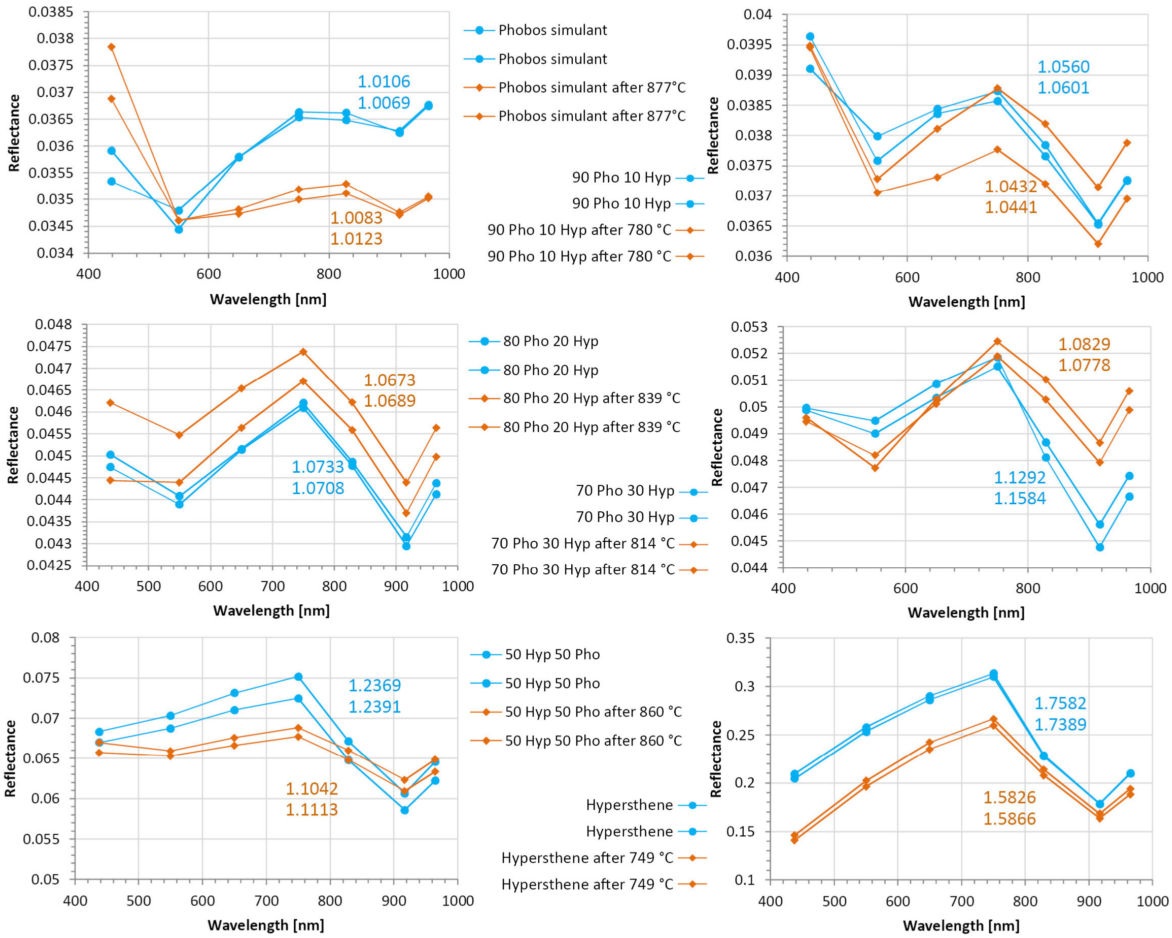

Figure 2: Reflectance spectra of the six experimental setups. 'Pho' and 'Hyp' denote the analogs: Phobos simulant and hypersthene. The colored numbers display the 750/917 [nm]-values of the individual spectra. Blue color denotes the spectra prior to the experiment, orange color the post-experimental spectra. Please note the different scales.

It is therefore advisable to create other analogs in the future and see whether this changes the basic outcome of our experiments.

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References: [1] Michalik et al. (2017) *EPSC abstract #2017-637*. [2] Denevi et al. (2012) *Science 338*, 246-249. [3] Roatsch et al. (2012) *Planetary and Space Science, 73*, 283-286. [4] Maturilli & Helbert (2016) *47th LPSC abstract #1986*. [5] Miyamoto et al. (2018) *49th LPSC abstract #1986*. [6] Jaumann et al. (2014) *Icarus 240*, 3-19. [7] McCord et al. (2012) *Nature Letter 491*, 83-86.