THE IDENTIFICATION OF LAVA/WATER INTERACTION THROUGH VNIR ANAYLSIS: A TRIAL STUDY AT JORDAN CRATERS, OREGON A. Reeder[1], E. Rader[1], A. Doloughan[1], S. Ackess[1], T. Sisson[2], and J. Heldmann[3]. [1]University of Idaho (reed9720@vandals.uidaho.edu) [2]USGS Menlo Park [3]NASA Ames

Introduction: The purpose of many future missions to Mars is searching for evidence of past life. Places that were once ancient water sources are more likely to have housed ancient life[1][2]. Volcanic eruptions that interact with water or ice create locations for ancient life on Mars as water/lava interactions on Earth are known to harbor microbial life [3]. Additionally, if volcanic deposits retain a signature of lava-water interaction, we can use the extent of the deposits to estimate the distribution of ancient water or ice on Mars.

Identifying areas of lava and water interactions has previously been done by either the visual identification of surface structures such as rootless cones[4] [5] or by identifying substantial mineral alteration, such as palagonite [6] [7]. However, on Earth these identifiers will not necessarily form if the interaction with water is brief, seasonal or if the ratio of lava to water is too low [8]. A more universal indicator that correlates with the rapid cooling that results from water-lava interactions is a 'quench texture' within the rock. These textures have fewer and smaller crystals incapsulated in a glassy matrix when compared with lavas that cooled in the air [9]. Developing a way to remotely identify these textures would reveal areas of ancient water or ice presence on Mars that could be studied in future missions.

These quench textures may be identifiable using Visible to Near Infra-Red (VNIR) spectroscopy [10]. Water-quenched lava has higher glass content that tends to deflect light away due to the amorphous structure which could result in lower levels of reflectance. Glass spectra has been identified as being lower than the center of the 2 µm band and higher than the center of the1 µm band centers on pyroxene rich lunar samples. [11]. Minerals that crystallize in lava have different VNIR spectra and samples with increasing crystal content will show potentially systematically different spectra, such as an increase the amount of reflected lighthat is lower than the center of the 2 µm band and higher than the center of thet 1 µm. t However, the level of reflectance can also be affected by whole rock chemistry, the percentage of phenocrysts, and the later formation of alteration minerals[12]. We developed a method to identify areas of water/lava interaction while taking into account these variables. First, we analyzed one lava field to characterize the whole rock chemistry, phenocryst content, and degree of alteration and determine how these variables change from the vent to the margins and if those changes had a significant effect on overall reflectance values over the lava field. By sampling over multiple different areas in the lava field, we can control for the original amount of phenocryst content and degree of alteration while analyzing VNIR signatures to show the potential relation between reflectance levels and glass content.

Methodology: Jordan Craters is a volcanic field in Southeastern Oregon, and was chosen because portions of the lava flow terminate in a lake while other margins were likely solely air-quenched [14]. The eastern margin of the youngest unit flowed down a stream bed and blocked off the water in the area, causing the later formation of Cow Lakes. We collected VNIR spectra using an ASD TerraSpec® Halo and a Bruker Tracer-IV SD X-ray fluorescence spectrometer (XRF).

We collected 279 spectra samples on multiple types of surface morphology and emplacement environments, including spatter, flow surfaces, and the east (water-quenched) and west (air-quenched) margins, over the course of three days. Morphologies like spatter erupting near the vents will air-quench rapidly resulting in the highest glass content within the lava field while the interior of the flow will be the most insulated and have cooled the slowest, resulting inthe lowest glass content of the sampled morphologies. In addition to targeting surface morphology and quench environment, we created a 1m by 1m grid with points every 1/2m to evaluate the variability of spectra in an otherwise homogenous seting.One to two hand samples were taken from each site, to allow for a quantitative comparison between measured crystallinity and reflectance levelsThe and were scanned in triplicate. We also scanned 2-3 other samples at each site using the ASD in triplicate. The ASD and XRF were sampled on relatively flat and lichen-free surfaces, holding the device steady in position during each of the three recordings and shielding from the sun.

We analyzed the VNIR data by looking for distinct patterns between the surface morphology and emplacement environments. We then imaged polished thin sections from the hand samples using electron backscatter diffraction on a scanning electron microscope (SEM). These images were analyzed using ImageJ by outlining the visible crystals and comparing the surface area of the crystals to the surface area of the glassy matrix.

Expected Results:. We hypothesize that a comparison with the quantitative SEM data and the VNIR data will show a trend with higher crystal contents correlating to higher reflectance. The water quenched margin of Jordan Craters should then have a glassier spectral signature (e.g. lower reflectance) than the air quenched surfaces and the highly crystalline interior sample .Overall the XRF data should show no major changes in composition over the single lava field and provide a baseline for comparison in future studies. If a correlation exists, then this same method could be applied to VNIR data from Mars to identify water quenched glass and help constrain the abundance of water on ancient Mars.

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