USING VNIR BAND CENTER LOCATION AS A PROXY FOR PALEO-HYDROCLIMATE ON MARS: A CASE STUDY. K. R. Frizzell[1] and L. Ojha[1], [1]Department of Earth and Planetary Sciences, Rutgers University, Piscataway, NJ, 08854, USA, (krf82@eps.rutgers.edu).

Introduction: The presence of water on Mars during the Noachian is evidenced by multiple studies and datasets [e.g., 1,2] including data taken by the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) [3]. CRISM has vast coverage of the Martian surface, making it a valuable scientific asset for revealing the fluvial history of our celestial neighbor. Hematite is often used to analyze water alteration and diagenesis on Mars through the detection of the gray, coarse-grained phase [4]. Hematite/Goethite ratios (Hm/Gt) also have been used terrestrially to assess short-term variations in aridity [5], but the detection of goethite using CRISM is difficult due to the detector boundary around 650 nm. Here we attempt to explore the feasibility of using the 530 nm band center to analyze hydroclimate at the time of formation by looking at an area with known hematite detections: Gale Crater.

Background: The 530 nm band parameter (BD530) has been traditionally used to assess the degree of oxidation of iron oxides on the surface of Mars, whereas the 860 nm signature has been used to inform the degree of crystallinity and grain size [6].

A study on the Earth in the North American red beds observed a correlation between the 530 nm band center and visual color in pigmentary hematite core samples, and surmised that the change was due to relative aridity as the pattern corresponded to intermittent monsoonal events [7]. A chemical analysis was done on the core sample to reveal that the observed trends were most likely not due to Al substitution for Fe within the hematite octahedral structure, but instead corresponded to grain size differences due to crystal growth and interaction with water. This suggests that the location of the band center may be tied to paleoclimate through grain size [7]. Another study on Namib dune sands also noticed a correlation between the 530 nm band center and visual color using remote sensing [8].

The band center of hematite has been speculated to shift between ~535 nm and ~570 nm depending on the surface area of individual hematite grains [9]. Larger grain sizes have colors in the blue/violet range of the visible spectrum due to an absorption of yellow light, and red/yellowish phases of hematite are correspondingly associated with smaller grain sizes and absorptions <550 nm [9]. Essentially, this means that larger grain sizes may correspond to more water interaction and a redder band center, whereas smaller grain sizes should correspond to less water interaction (a more arid environment) and bluer band centers.

Vera Rubin Ridge (VRR) is on the northwest flank of Mount Sharp in Gale Crater and contains a spectral 'hotspot' of hematite that has been studied both orbitally and in situ [10]. Evidence of both red (fine grained) and gray (specularite, with larger grains) hematite phases have been detected on VRR, making it a prime target for investigating potential spectral band center differences due to fluid diagenesis. Evidence for grain size differences was found primarily through the band depth at 530 nm and 860 nm [11], where a shallower absorption band indicates gray, coarser-grained hematite, and deeper absorption bands correlated to more fine-grained red hematite.

Fraeman et al. (2020) [11] proposed that the difference in hematite grain sizes was due to late-stage diagenetic fluid alteration, which could potentially be corroborated using the band center method described here.

Methods: The data used in this study were full-resolution targeted (FRT) map-projected (TRR3) images in the visible range of CRISM [3]. One image has been assessed thus far (FRT00021C92). The focus of this study was to test whether there is a visible difference in the band center of the 530 nm absorption band in images with hematite present that could correspond to diagenetic alteration or paleoclimate.

Data were selected based on existing literature that cited the presence of hematite using ground-based and orbital studies [10,11]. CRISM images were downloaded from the PDS and processed using the CAT software on ENVI. Processing included a step to correct for solar incidence angle and cube continuum removal.

The FRTs were then spectrally inverted and run through a peak finding algorithm that isolated peaks of width 0.05 nm or larger in order to filter out noise. The wavelength location of the selected peaks was identified and assigned as the pixel value in the new image. Band depths were also calculated using the peak finding algorithm by finding the prominence of the 530 nm band.

Preliminary Results: Results from [11] showed that VRR has an abundance of deeper ~860 nm absorptions, which are most likely reflective of the grain size variation and not the abundance of ferric crystalline phases. With a variation in grain size due to late-stage diagenetic fluids, we should theoretically see a marked difference in the 530 nm band center, based on the study from [7]. Vera Rubin Ridge appears to have elevated 530 nm band depth values, reflective of its hematite content, but so far, we see no significant variations in the band center positions of the 530 nm absorption band at VRR (see *Figure 1*).

Discussion: There appears to be little correlation so far between the calculated 530 nm band center and the 530 nm band depth (see Figure 1). It is possible that the resolution needed for this kind of study is unobtainable using the spatial resolution of orbital satellite data, however, a terrestrial remote sensing study of the Namib dunes was able to detect this band center shift [8]. Perhaps the data needs to be processed further to remove atmospheric effects. The Earth-based study [7] was shown to work on hematite-rich beds in core samples (outcrop scale), so doing this analysis from space may require larger and more coherent units. New MSV products generated from CRISM data [12,13] may allow us to better assess the correlation between BD530 and the 530 nm band center globally, or regionally over areas of interest.

We intend to increase our case study to include more areas, like the Meridiani region, and utilize the DISORT model to better process the data.

Acknowledgments: I would like to acknowledge the Planetary Data System (PDS) for providing the CRISM MTRDR (FRT00021C92), as well as Rutgers University and my advisor Dr. Lujendra Ojha for funding and supporting this project.

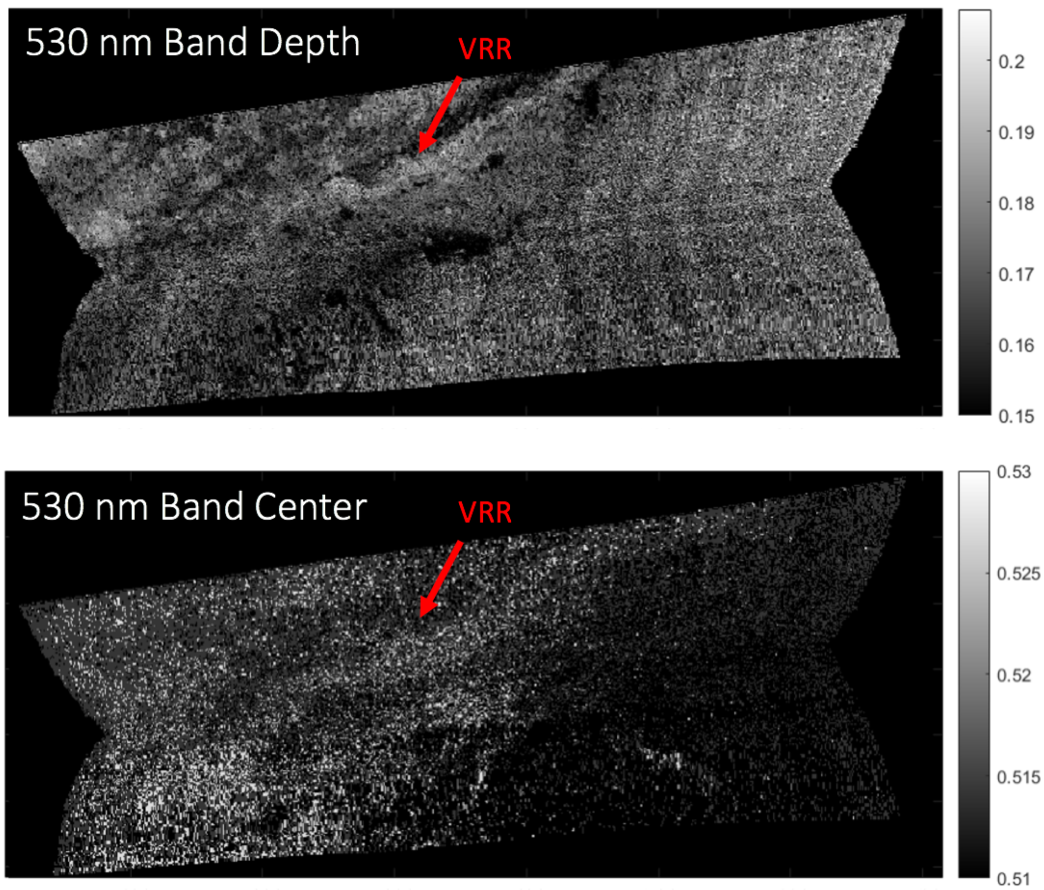

Figure 1: The 530 nm band depth map of FRT00021C92 (above) and the 530 nm band center map produced by this work (below) with the hematite ridge [9] marked by a red arrow.

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