VENUS SURFACE OXIDATION AND WEATHERING AS VIEWED FROM ORBIT WITH SIX-WINDOW VNIR SPECTROSCOPY.

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Introduction: Knowledge of Venus mineralogy is key to constraining surface/atmospheric interactions as they contribute to our understanding of weathering reactions [1] and identify sites of recent volcanism [2]. As basalt weathers, first reacting with SO_2 and CO_2 and then oxidizing, its emissivity should transition from high to low, culminating in formation of new mineral alteration products. These reactions are likely defined by progressive oxidation of iron from Fe^{2+} to Fe^{3+} surface minerals as first suggested in 1964 [3]. This project uses laboratory data to assess whether iron oxidation and changes in mineralogy due to surface/atmosphere interactions can be detected from orbit using a six-window orbital spectrometer [4,5].

Samples and Methods: Rocks and minerals examined include six rocks: two basalts, basaltic andesite, granite, rhyolite, and rhyolitic glass; and four minerals: pyrite, pyrrhotite, magnetite, and hematite. Compositions were determined by x-ray fluorescence (XRF) at the University of Massachusetts [6] or by electron microprobe at Brown University. Fe^{3+}/Fe^{2+} ratios were measured using Mössbauer spectroscopy. Visible near-infrared (VNIR) data were collected in the Planetary Spectroscopy Laboratory (PSL) at the German Aerospace Center (DLR) in Berlin [7].

Oxidation State Results: Figure 1 (top) shows the relationship between the internsity of the 1.18 µm band and iron oxidation state. Samples that are dominated by Fe^{2+} have the highest emissivities, while those containing Fe^{3+}, like magnetite ($Fe^{3+}_2Fe^{2+}O_4$) and hematite ($Fe^{3+}_2O_3$), have the lowest. Inspection of the entire spectral range shows that magnetite has the largest negative slope of any sample measured between 0.86 to 0.91 µm. All the felsic rocks also have negative slopes in that region, while Fe^{2+}-rich basalts are distinguished on the basis of their positive slopes. Results show that metrics can easily be developed to assess oxidation state of Venus surface rocks.

Surface-atmosphere chemical reactions also result in changes in mineralogy that cause both gradual and sudden changes to radar backscatter at higher elevations. No one mineral satisfies all the current observations that could account for these changes [8]. Compounds such as pyrite, pyrrhotite, magnetite, hematite,

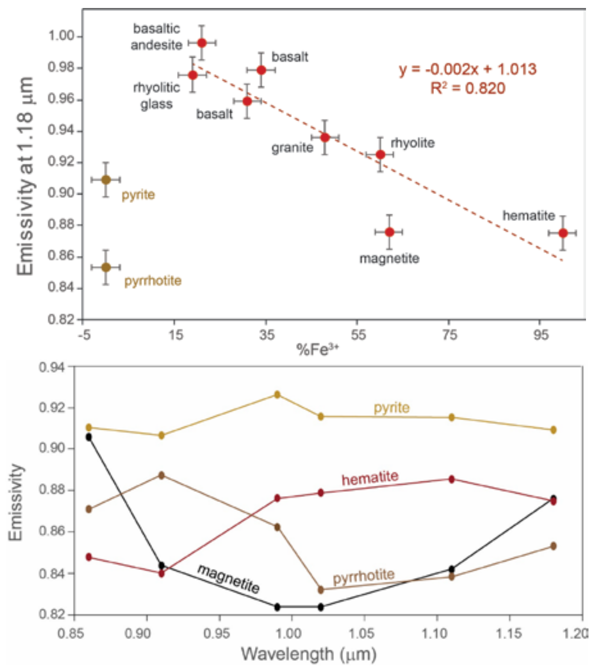

Figure 1. (top) Relationship between the magnitude of emissivity at 1.18 µm versus total iron contents, expressed as the percentage of the total iron that is Fe^{3+}. Pyrite and pyrrhotite are not expected to lie on this trend line because their spectra are so affected by the dominantly covalent bonding in their structures. (bottom) Diagnostic emissivity spectra of possible alteration products from surface-atmosphere interactions at the six observable wavelengths.

chlorapatite and others [8,9] have been proposed by various workers to cause these changes (Figure 1 bottom). Our data show that at least four of these minerals have distinctive spectral signatures that should be sufficient to distingui them on Venus highlands. Acquisition of additional spectra data is underway to further constrain this observation.

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