AGU FALL MEETING

San Francisco | 15–19 December 2014

Visible and near-infrared spectra of manganese oxides: Detecting high manganese phases in Curiosity Mastcam multispectral images

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Abstract:
The Mars Science Laboratory *Curiosity* rover's Chemcam instrument has identified manganese in relatively high abundance on several rock surfaces. The manganese abundances are several orders of magnitude greater than has been previously identified on Mars, indicating the presence of a manganese-rich phase. Although the specific phase has yet to be identified, these results suggest that the martian surface may have been much more highly oxidizing than has previously been recognized. The presence of a manganese-rich phase could provide an additional indicator of habitable aqueous environments. Given the importance of manganese for understanding past habitability, and the high abundances identified with Chemcam, we investigate the utility of using Mastcam multispectral imaging surveys to identify areas for subsequent detailed analysis with Chemcam. Vempati *et al.* showed that Mn^{3+} affect the reflectance spectra of Mn-bearing minerals. Specifically, relatively weak features due to electronic transitions and crystal field effects are observed in Mn-enriched hematites and geothites at 454, 554, 596 and 700 nm. The Mastcam-34 medium angle camera has filter band-passes at 550, 675 and 750nm, and we will explore the utility of using these bands (or combinations thereof) to determine if there is a contribution of Mn-bearing phases on spectra, specifically those that have been identified as having elevated Mn with Chemcam. The most common Mn-bearing mineral phase in terrestrial varnishes, Birnessite, has charge-transfer features that are similar to Fe-oxides but are centered at slightly longer wavelength band positions. Longer wavelength features are also common for other Mn-oxides, and this could be used to distinguish these phases from other Fe-oxide components. In this study we will present visible to near-infrared (0.4 – 3 µm) reflectance spectra on a suite of Mn-oxide laboratory standards. The set of standards includes Mn-oxide abundances that vary from less than 1 up to ~75 wt.%. Spectra will be downsampled to Mastcam bandpasses to determine if the effects of Mn-bearing phases could be identified from Mastcam multispectral observations in Gale Crater.

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