DETECTION LIMIT OF SMECTITE BY CHEMIN IV LABORATORY INSTRUMENT: PRELIMINARY IMPLICATIONS FOR CHEMIN ON THE MARS SCIENCE LABORATORY MISSION. C. N. Achilles[1], D. W. Ming[2], R. V. Morris[2] and D. F. Blake[3], [1]ESCG/Hamilton Sundstrand, Houston, TX 77058, cherie.n.achilles@nasa.gov, [2]NASA Johnson Space Center, Houston TX 77058, [3]NASA Ames Research Center, Moffett Field, CA 94035.

Introduction: The CheMin instrument on the Mars Science Laboratory (MSL) is an miniature X-ray diffraction (XRD) and X-ray fluorescence (XRF) instrument capable of detecting the mineralogical and elemental compositions of rocks, outcrops and soils on the surface of Mars. CheMin uses a microfocus-source Co X-ray tube, a transmission sample cell, and an energy-discriminating X-ray sensitive CCD to produce simultaneous 2-D XRD patterns and energy-dispersive X-ray histograms from powdered samples. Instrument details are provided in [1,2,3].

CRISM and OMEGA have identified the presence of phyllosilicates at several locations on Mars including the four candidate MSL landing sites: Mawrth Vallis [4], Holden Crater [5], Eberswalde [5], and Gale Crater [6]. Regardless of which of the landing sites are chosen for MSL, samples containing phyllosilicates will almost undoubtly be introduced into the CheMin instrument. Samples that contain major quantities of phyllosilicates will be easily detected by CheMin. However, samples may contain minor quantities of phyllosilicates, e.g., soils around a phyllosilicates-rich deposit where eolian additions are possible. Therefore, laboratory studies are required to determine the detection limits of phyllosilicates (and other minerals) in mixed mineral systems. The objective of this study was to conduct preliminary studies to determine the CheMin detection limit of smectite in a smectite/olivine mixed mineral system.

Materials and Methods: A smectite, predominantly montmorillonite from Cheto Mine, AZ and an olivine from Twin Sisters Mine, Oregon were mixed in varying proportions to provide a two mineral system. Samples were first ground and sized to <45μm then manually mixed by grinding to four smectite weight percent ratios: 3%, 2%, 1%, 0.5%. A sample with no smectite was also analyzed to provide baseline comparisons.

Several laboratory versions (CheMin IV) of the CheMin flight unit have been built to test the capabilities of the instrument. NASA Johnson Space Center is the home of one of those CheMin IV units. Samples were analyzed by averaging 1000 exposures, each with a 30 second duration (~10 hours) in order to obtain a pattern with ample intensity:background ratios. A Mylar sample cell was used to minimize any low angle contamination diffraction patterns (Kapton cells will also be used for corrosive samples on MSL, but have a diffraction peak at approx. 6.5° 2θ). CheMin IV utilizes a piezoelectric vibration device on the sample cell to randomize particle to reduce perferred orientation effects.

Results: Figure 1 shows a comparison of the dominate smectite peak at 7° 2θ for each of the five samples. A background line based upon the slope of the sample without smectite was produced for each sample and represents a baseline for comparison. The 3%, 2%, and 1% smectite samples each show distinct height differences from the background. The 0.5% sample has a slight peak while the 0% shows no significant difference from the baseline. The preliminary results suggest that smectite present at abundances greater than 1 wt. % are enough to produce a distinct peak with a measureable intensity. While the 0.5 wt. % sample shows a very modest peak, the difference from the 0 wt. % sample may not be significant enough for a definitive identification of smectite or other 2:1 expandable phyllosilicate.

Implications for MSL: The CheMin IV instrument was able to detect 0.5 wt. % smectite in mixed smectite/olivine samples; although the peak was not distinctly different than the baseline. The (001) peak for the 1 wt. % smectite was distinct from the background. These mineral mixtures simulate an addition of smectite to the olivine matrix (e.g., eolian addition); therefore, the detection of smectite forming on the surface of olivine as a weathering product may have different detection limits due to orientation effects.

These results are preliminary. We plan to conduct many additional tests on the CheMin IV instrument between now and MSL landing to provide a detection limit guideline for some of the mineral phases that MSL is most likely to encounter. Additional studies will need to be conducted on the CheMin Demonstration Model (DM) located at JPL. The CheMin DM is flight-like and will provide the most MSL CheMin-like analyses. However, the number of samples that can be analyzed on the CheMin DM are limited; hence, much of the “leg work” will be conducted by the laboratory CheMin IV instruments.

References: [1] Blake D. F. et al. (2010) *LPSC XLI*, Abstract #1896. [2] Blake D. F. et al. (2009) *LPSC XL*, Abstract #1484. [3] Blake D. F. et al. (2007) *7th Int. Conf on Mars*, Abstract #3220. [4] Mustard J. F. et al. (2008) *Nature, 454*, 305–309. [5] Milliken R.

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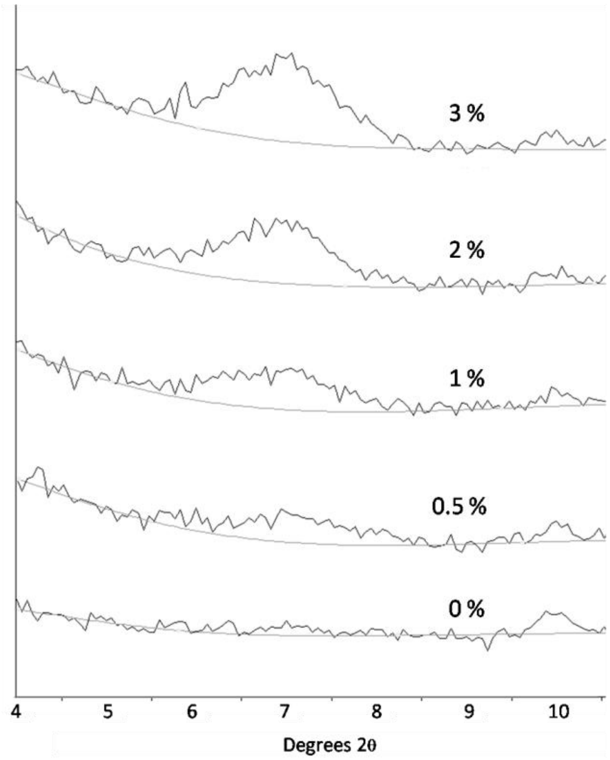

Fig. 1 *Comparison of the dominant (001) smectite peak for 3, 2, 1, 0.5 and 0 wt. % smectite in mixtures with olivine. Each has a background line representing the baseline spectra for 0 wt. % smectite.*