**CRISM HYPERSPECTRAL MAPPING DATA PRELIMNARY EMPIRICAL RADIOMETRIC RECONCILIATION.** M. S. Phillips[1], F. P. Seelos[1], S. L. Murchie[1], [1]Johns Hopkins Applied Physics Laboratory, 11100 Johns Hopkins Rd, Laurel, MD 20723, Michael.Phillips@jhuapl.edu.

**Introduction:** Investigations of the martian surface with CRISM and OMEGA data have revealed temporally heterogeneous aqueous alteration of Noachian crust. Whereas pre- to early Noachian crustal alteration was dominated by reactions with neutral pH fluids to form phyllosilicates and carbonates, late-Noachian alteration of crustal rocks was dominated by reactions with low pH fluids to form sulfates [1]. Although a general story of the temporal variations in alteration of the martian crust has come into focus in the past 15 years, questions still remain about spatial variations and the extent of alteration. How widespread are occurrences of pre-Noachian Ca/Fe carbonate, and what does their occurrence imply for the chemistry of early wet environments? How continuous is aqueous alteration at depth, and what is the balance of alteration to hydrated silica (at lower water/rock ratio) versus phyllosilicate (at higher water/rock ratio)? What is the distribution of phases that imply deep diagenetic to low-grade metamorphic environments (epidote, prehnite), and what does the answer imply for early Martian crustal evolution? How widespread are acid sulfates in layered clay deposits, and what does their occurrence and distribution imply for the transition from a neutral weathering environment to an acidic one? To address these questions, we are employing a relatively under-utilized type of CRISM data, namely the 200-m/pixel, 262-channel hyperspectral "mapping" (HSP) data.

**Background:** The CRISM data products that have been most commonly used to identify alteration minerals on Mars can be broadly categorized as either targeted observations or multispectral "mapping" (MSP) strips. CRISM targeted observations have several formats having pixel scales of ~20 to 40 m/pixel with continuous hyperspectral sampling over 545 wavelength channels at ~6.5 nm/channel. Most cover an area of approximately 100 km$^2$ [2]. Targeted observations therefore provide high spatial and spectral resolution information, but over a relatively small area on Mars (~2% of the martian surface). Conversely, CRISM 72-channel, 200 m/pixel MSP data cover ~85% of the globe, but come with a sacrifice of spectral, and consequently compositional, resolution. Regional-scale alteration has been identified with the MSP dataset [3]–[6], but detailed interpretation of mineral chemistry, such as distinguishing between phyllosilicate Fe/Mg content, carbonate Ca/Fe content, and hydration states of silica, is difficult with the limited channels available in the MSP dataset.

CRISM 262-channel, 200 m/pixel hyperspectral mapping (HSP) data cover ~39% of Mars. The strength of HSP data, compared with 72-channel MSP data, is contiguous hyperspectral wavelength coverage at 0.36-1.02, 1.36-1.51, 1.86-2.01, and 2.08-2.56 µm, the wavelength regions richest in mineralogically diagnostic absorptions that discriminate the chemistries of hydrated silica, clays, and carbonates. The denser spectral sampling also gives HSP data advantages over MSP data that include the possibility to apply advanced noise remediation, increased capability to distinguish weak absorptions and differentiate between spectrally similar minerals, and detection of absorptions not foreseen when the MSP channel set was specified prior to launch. For this study, we investigate three test regions to explore techniques to remediate noise and radiometric discrepancies between mapping strips in the HSP dataset. The test regions are tiles 404, 476, and 741 from the CRISM map tile scheme (Fig. 1). They are drawn from regions that are known from targeted observations to exhibit different types and abundances of secondary minerals.

**Methods:** Variations in illumination geometry, atmospheric state, and instrument conditions (e.g., IR detector temperature) result in radiometric discrepancies between individual CRISM mapping strips. The relatively high density of spatial overlap between MSP mapping strips (e.g., Fig. 1) enables application of wavelength-dependent "optimization parameters" to transform component strips into a consistent radiometric framework tied to the highest quality data in the mosaic region [7]. HSP data are sparsely connected spatially compared to MSP data, making this approach to achieving a consistent radiometric framework for the HSP data alone infeasible.

To restore HSP data to a consistent radiometric framework, we instead use spectrally downsampled versions of the HSP data (which have been included in the construction of 72-channel MSP map tile mosaics [7]) to retrieve wavelength-specific linear least squares optimization parameters for the 72-channels of the HSP data that are included in the MSP channel set. An interpolation of these optimization parameters as a function of wavelength will be used to estimate optimization parameters for the intervening wavelengths for which parameters cannot be calculated directly. A wavelength-dependent linear transformation of the HSP data that reduces scene-to-scene discrepancies in radiometry will then be employed, and noise mitigation applied.

**Results:** Preliminary construction of non-radiometrically reconciled HSP tile mosaics overlayed on MSP data (Fig. 2) shows both the benefit of improved spectral continuity of HSP data as well as the

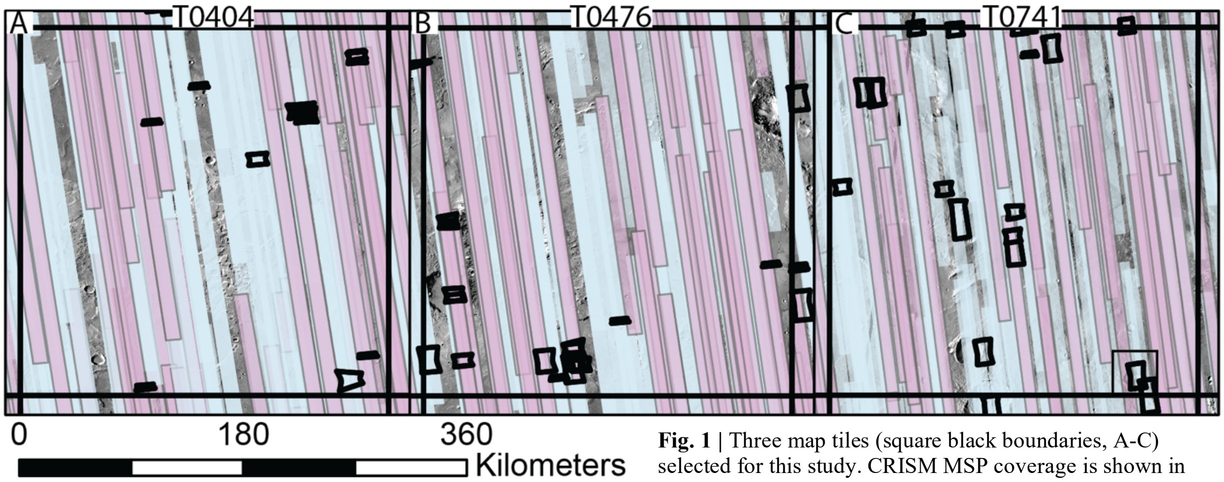
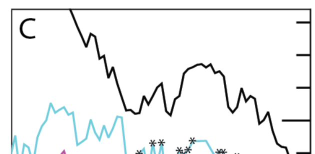
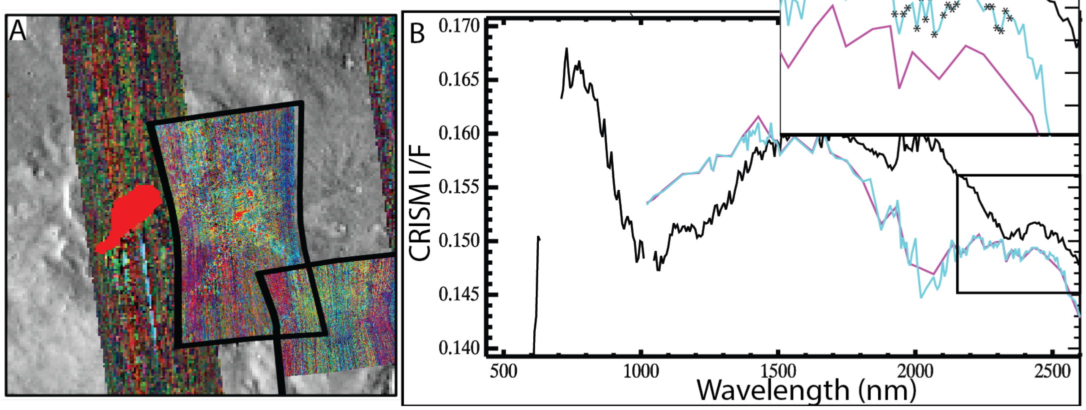



**Fig. 1** | Three map tiles (square black boundaries, A-C) selected for this study. CRISM MSP coverage is shown in light blue, and HSP coverage is shown in pink. Targeted observations are outlined in black.

**Fig. 2** | Spectra from CRISM targeted observation HRL0001953B (black spectrum in B, C) and HSP mapping strip HSP00025D7C_01 (light blue spectrum in B, C) within tile 741. The version of HSP00025D7C_01 in magenta has had its number of wavelengths downsampled to the MSP wavelength set. Note asterisks in panel C indicating select extra wavelengths provided by the HSP channel set in the 2300-nm region. In A, R=BD235, G=D2300, B=BD2290. Notable differences between mapping data and targeted data around 1.5 and 2.0µm are likely due to ($CO_2$) ice haze in the HSP scene, which was taken at Ls 127 (southern winter on Mars).



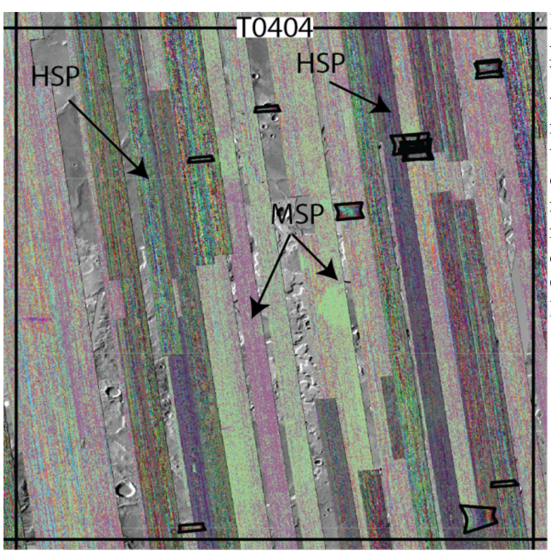




**Fig. 3** | **Fe**/Mg phyllosilicate browse product over tile 404 with radiometrically uncreconciled HSP data overlain on radiometrically reconciled MSP data. R=BD2355, G=D2300, B=BD2290.

need for radiometric reconciliation between individual HSP mapping strips (Fig. 3). Initial results show promise for extending the continuous wavelength coverage provided by CRISM targeted observations to the greater area covered by HSP mapping strips, which will address questions about spatial variability in mineral chemistry.

**References:** [1] J. P. Bibring et al., (2006), Science (NewYork, N.Y.), 312, 5772, 400. [2] S. Murchie et al., (2007), *JGR*, *112*, E5, doi: 10.1029/2006JE002682. [3] C. E. Viviano, (2019), LPSC, #2132. [4] C. E. Viviano and M. S. Phillips, AGU Fall Meeting 2021 #813941. [5] A. M. Dapremont, C. E. Viviano-Beck, et al., (2017), LPSC, #2440. [6] C. E. Viviano-Beck et al., (2020), LPSC, #1485. [7] F. P. Seelos and S. L. Murchie, (2018), LPSC, #2325.