ANALYSIS OF COLOUR AND STEREO SURFACE IMAGING SYSTEM (CaSSIS) COLOUR CAPABILITIES AND SIMULATED IMAGES GENERATED FROM MRO DATASETS. L. L. Tornabene[1], F. P. Seelos[2], A. Pommerol[3], K. T. Hansen[1], N. Segal[1], N. Thomas[3], G. Cremonese[4], A. S. McEwen[5], S. Sutton[5], M. Chojnacki[5], [1]Centre for Planetary Science & Exploration (CPSX) and Dept. of Earth Sciences, Western University (1151 Richmond Street, London, ON N6A 5B; ltornabe@uwo.ca), [2]JHU/APL, Laurel MD, [3]Physikalisches Institut, Universität Bern, Sidlerstrasse 5, CH-3012 Bern Switzerland, [4]INAF, Osservatorio Astronomico di Padova, Vicolo dell'Osservatorio 5, 35122 Padova, Italy, [5]LPL, University of Arizona, Tucson, AZ.

Introduction: The Colour and Stereo Surface Imaging System (CaSSIS) is full-colour visible to near-infrared (VNIR) bi-directional pushframe stereo camera onboard the ExoMars 2016 Trace Grace Orbiter (TGO). CaSSIS will provide stereo colour images 9.48 km wide and up to ~47-km long with a 20-degree parallax angle; at their highest un-binned resolution, these images will yield a pixel scale of 4.62 m/pixel and provide up to 4 broadband colour channels covering ~500 to 950 nm [1]. These observations are anticipated to provide high-resolution full-colour stereo image pairs that will compliment previous and future Mars datasets. As such, this study seeks to simulate CaSSIS images using existing Mars Reconnaissance Orbiter (MRO) datasets to: 1) evaluate colour capabilities, particularly sensitivity to various Fe-bearing surface materials, 2) determine best practices for imaging modes based on regional and local surface properties to inform a image band selection that optimizes colour diversity while accounting for operational constraints (e.g., # of observations per orbit, data volume management, etc.), and 3) provide additional inputs for instrument calibration during the cruise phase of the mission. Here we present the results of our study. For more details on CaSSIS, please see [1].

Table 1. CaSSIS Bandpasses.

#/Name	Band Centre	Bandwidth	Colour
1/BLU	500 nm	130 nm	**Blue-Green**
2/PAN	675 nm	250 nm	**Red**
3/RED	850 nm	120 nm	**NIR**
4/NIR	950 nm	150 nm	**NIR**

CaSSIS Image Simulation: Hyperspectral VNIR (S-detector) data from the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) covers 362 – 1053 nm [2], consistent with the CaSSIS wavelength range (Table 1). As such, CRISM Targeted Reduced Data Records (TRDRs; calibration v3) are used to generate 4-band "CRISM Corrected CaSSIS Compatible" (CCCC) image cubes, which provides CaSSIS colours at CRISM spatial scales (Fig. 1). The first step in the process is to correct the CRISM data for photometric effects traceable to the continuously varying observation geometry (gimbal motion) [3]. The resulting image cube is structurally consistent with a CaSSIS pushframe acquisition. The spectral transform then consists of: 1) converting the corrected CRISM I/F data to spectral radiance, 2) convolving the CRISM radiance spectra to the 4 CaSSIS bands using the latest calibrated bandpasses, and 3) converting the result back to I/F. In turn, the colour provided by a map-projected CCCC product may be combined through a Hue, Saturation, Value (HSV) transform [4] with the morphology provided by spatially resampled Context Camera (CTX) and High Resolution Imaging System (HiRISE) products to generate a simulated image that is spatially and spectrally consistent with CaSSIS (Fig. 2).

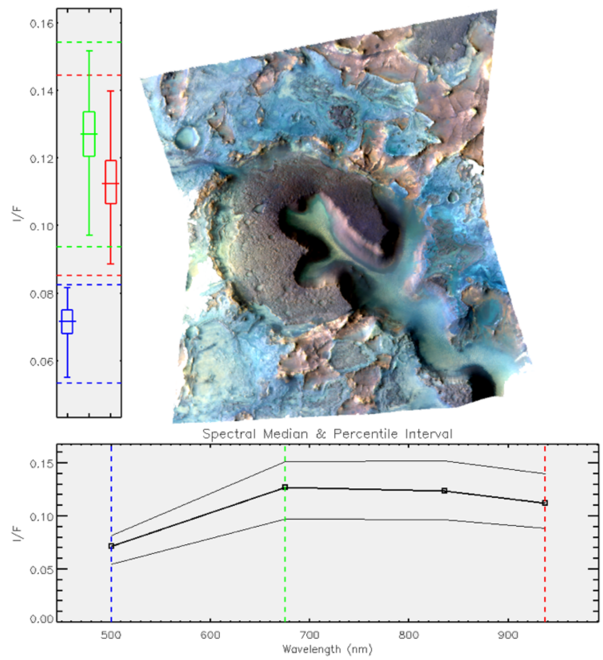

Fig. 1. Simulated CaSSIS infrared-colour (**4-2-1**) image from a CCCC derived from CRISM FRT00003E12 (Nili Fossae region). The median spectrum with 1-99 percentile envelope and band **4-2-1** boxplots illustrate the spectral/color variability of the scene.

CaSSIS Colour Capabilities and Fe-Sensitivity: Ferric- and ferrous-bearing minerals generally possess broad VNIR absorptions near 550 and 800, and 1000 nm, respectively, due to electronic transitions [e.g., 5]. Mineral spectral libraries from the USGS [6] and the CRISM team [7] were convolved to the CaSSIS bandpasses. Ratios of the CaSSIS-resampled lab spectra for selected Fe-bearing minerals observed on Mars are plotted here on bivariate plots (Fig. 3) to see how well CaSSIS discriminates between ferric- and ferrous-bearing materials. Based on the separation of ferrous and ferric mineral groups in these plots, CaSSIS colour

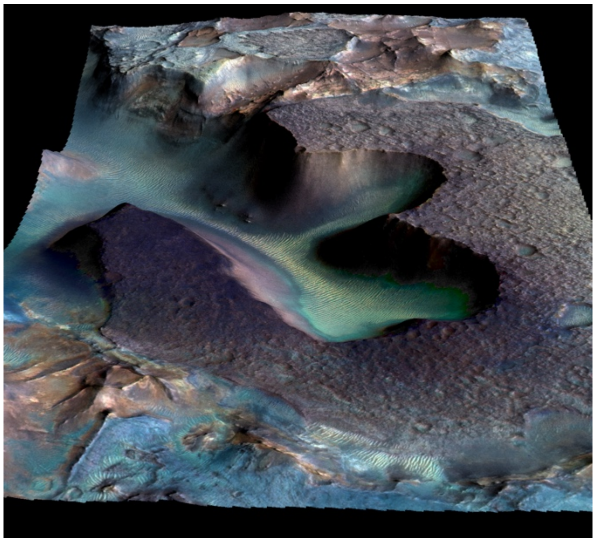

Fig. 2. A 3D perspective of a fully-simulated CaSSIS image (looking SSE). This composite is based off of a combination of the CCCC (FRT00003E12), and a spatially resampled CTX (P03_002176_2024) and HiRISE DTM (DTEEC_002888_2025_002176_2025). VE = 2x.

composites (i.e., 4-2-1 – similar to a HiRISE IRB image) should have adequate sensitivity to generally discriminate between the two groups. Additionally, CCCCs were generated from 27 CRISM image cubes representing 31 mineral spectra type-localities summarized by Viviano-Beck [8]. **R-G-B** colour composites from these 4-band CCCCs, including a band ratio composite using **4/1-2/1-2/4**, were evaluated based on their colour diversity by comparing the number of distinctive colours in each composite (including the colour at the reported location of each mineral type-locality in a particular image cube [8]), and then by extracting and comparing 4-point spectra from each spectral unit. This analysis focused specifically on assessing appropriate image modes for CaSSIS. For example, a dusty region on Mars would at a minimum require an image mode that uses only the **PAN** band because it is spectrally bland. Conversely, spectrally diverse regions containing multiple types of Fe-bearing minerals (e.g., Nili Fossae), require 3 bands (**4**- or **3-2-1**) to maximize colour diversity. Interestingly, the initial results of our analysis reveals that the spectrally diverse Mawrth Vallis region, may only require 2-band images (i.e., Bands 1, 2) from which a synthetic true colour image may be created (similar to how a HiRISE RGB is generated [see 4]). This is because the synthetic true colour image captured the same number of distinctive colours as the CaSSIS 3-band colour composites using the additional bands 3 or 4.

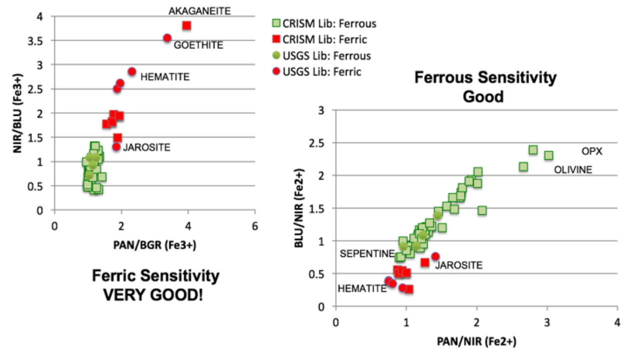

Fig. 3. Bivariate plots of band ratios generated from CaSSIS-convolved selected mineral library spectra provided by the USGS and CRISM team.

Future Work: Our future work considerations are as follows: 1) Generate additional CCCCs outside of the CRISM mineral spectra type locality regions, 2) Consider additional image modes for special cases such as change detection (e.g., seasonal processes, frost/ice, fading/darkening features, 3) Contribute to calibration efforts during the cruise phase, 4) Create target suggestions for type-localities, and 5) Acquire actual CaSSIS images for comparison with the CCCCs and fully-simulated CaSSIS images.

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