
Introduction: Global-scale compositional mapping on Mars has revealed broad regional trends in surface petrologic types. Mineral abundance mapping using thermal infrared datasets have been used to identify regional differences that reflect lithologic variability in primary surface composition. Mineral occurrence mapping in the visible and near-infrared wavelength range, though sensitive to primary mineral composition, is also particularly useful for mapping and identifying secondary mineralogy, including specific phyllosilicate species, hydrated sulfates, iron-oxides, and carbonates. Here we summarize the results of several ongoing efforts to use Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) [1] 72-channel, 180-m/pixel multispectral mapping data to map both primary and secondary mineralogy. We have developed a mapping methodology unique to this dataset that utilizes targeted observations, extracted spectra, and unique combinations of custom browse products to highlight mineral diversity in each region.

Methods: The CRISM multispectral mapping observations are compiled into 5°x5° tiles. Data are assembled using a processing pipeline that includes photometric and atmospheric corrections, as well as calculation, balancing, and noise filtering of standard summary parameters [2], and finally map projection and mosaicking of each CRISM image. The processing pipeline has been upgraded significantly over the last several years [3]. For each project, the tiles that cover the study region are compiled into a series of 3-color summary parameter composites (browse products) which highlight particular mineral assemblages [2]. Targeted observations (18–36 m/pix) that overlap the regions of interest are used to verify mineral identification and perform localized spectral analyses. Because of the reduced spectral sampling of the multispectral mapping data, often groups of spectrally-similar ‘classes’ rather than exact mineral species are mapped (e.g., Fe/Mg-phylllosilicate vs. Fe-saponite). Mapping for all projects was performed in ArcGIS using Thermal Emission Imaging System (THEMIS) daytime IR and qualitative thermal inertia [4,5], Mars Orbiter Laser Altimeter (MOLA) [6] for regional morphologic context, and Context Camera (CTX) [7] and High Resolution Imaging Science Experiment (HiRISE) [8] data for morphologic characterization of mapped units. Features are typically mapped at the ~1:250K scale and depending on the project, certain or approximate line styles were used to convey confidence in the mapped units.

Results from regional CRISM mapping: Below we summarize regional mapping projects that have been performed using recent prototypes of the upgraded tiled CRISM data (see Fig. 1 for extent of each study region). Figure 2 shows subsets of the finalized mapped units from each of the six study regions.

Regional Noachian mapping [9,10]. Mapping of primary and secondary minerals in several regional Noachian-aged terrains revealed variability in the extent of

![Figure 1](image1.png) Figure 1. Near-global view of Mars (MOLA shaded relief) with study regions overlain in color. While some regions overlap, the focus of those mapping efforts differ (e.g., mapping of primary vs. secondary mineral phases).
alteration across regions, and both similarities and differences between primary mineral spectral signatures across regions.

_Huygens crater_ [11,12]. Mapping suggests that the emplacement of olivine and high-Ca pyroxene (HCP) rich plains occurred after Huygens’ formation. A relative lack of alteration interior to the peak ring suggests substantial aqueous activity was not long-lived here.

Alteration associated with Isidis and Hellas [13-15]. Near-basin alteration is compositionally distinct from that at greater distances. Secondary minerals exposed by craters between Isidis and Hellas reveal trends with both depth and proximity to the basins.

_Valles Marineris light-toned layered deposits_ [16]. Mapping shows that phyllosilicate and hydrated silica in the plateau surrounding Valles Marineris correspond spatially to reflectors detected with SHARAD in the shallow subsurface.

_Ladon Basin_ [17]. Mapping of mafic units in and around Ladon Basin allowed for ring structures to be inferred by connecting arcuate series of low-Ca pyroxene (LCP) enriched knobs in combination with morphologic or topographic features.

_Northern Hellas Basin Rim_ [18,19]. Primary material present in uplifted massifs along the northern rim of Hellas basin were mapped and their distance to the basin center analyzed to show evidence for preexisting stratigraphic heterogeneity in the pre-Hellas crust.


Figure 2. Summary compositional map product from each of the study regions. Subset areas of interest are shown for larger regions of study (e.g., Nili Fossae for the Alteration associated with Isidis and Hellas study). Frame color for each panel corresponds to study regions represented in Figure 1.