CARBONATE-OLIVINE-PHYLLOSILICATE ASSOCIATIONS ACROSS THE NOACHIAN-HESPERIAN BOUNDARY.

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Introduction: Central to developing a deeper understanding of the hypothesized mineralogic transition across the Noachian-Hesperian boundary [1] are stratigraphic sections that capture the essential geologic processes across this time horizon. While the deposits within Gale Crater [2, 3], which contain phyllosilicate-bearing beds at the base of a stratigraphic section overlain by sulfate-rich sediments, may capture this transition, these sedimentary deposits may represent transported sediments and not the environment of formation of the indicator minerals [e.g. 4]. In contrast, the region of NE Syrtis (Figure 1) is attractive because mineral-bearing strata containing apparently unaltered and altered rocks (reactants and products) are in close proximity and in place, and where the timeline of geologic processes are well understood. In particular are the relationships among clay-bearing Noachian basement and an overlying olivine-rich unit that is variably altered to carbonate.

In Nili Fossae, carbonate is intimately associated with an olivine-rich unit [5]. Near-surface weathering by small amounts of water, serpentinizing hydrothermal systems, deep hydrothermal convection cells, metamorphic, and sedimentary/lacustrine deposits within ultramafic catchments have been proposed to explain these atypical (at least in comparison to Earth) Mg carbonates [5-10]. To advance our understanding of the environments of formation of carbonate here, we are pursuing four key outstanding questions: (1) How does the association of olivine and carbonate vary across the region from the northern highlands to the lowest elevations associated with the post-Syrtis fluvial system? (2) How do the carbonate and olivine absorption bands vary (and by inference mineralogy) across the region and with geologic context? (3) What is the relationship between exposures of clay mineral bearing outcrops and the olivine-carbonate unit? (4) How does the character of the clay-olivine-carbonate association change across the region. Here we focus on a transect of observations from the highest topographic location north of Nili Fossae to the lowest elevations near the boundary with Syris Major and proximal to Jezero crater (Figure 1), with an emphasis on the carbonate features.

Methods: All CRISM observations in the region 15-24° N and 75-80°E have been systematically processed using the most up-to-date data from the CRISM archive (TRR3). We applied the systematic processing steps to convert the I/F data to apparent surface reflectance using the most current volcano-scan correction.

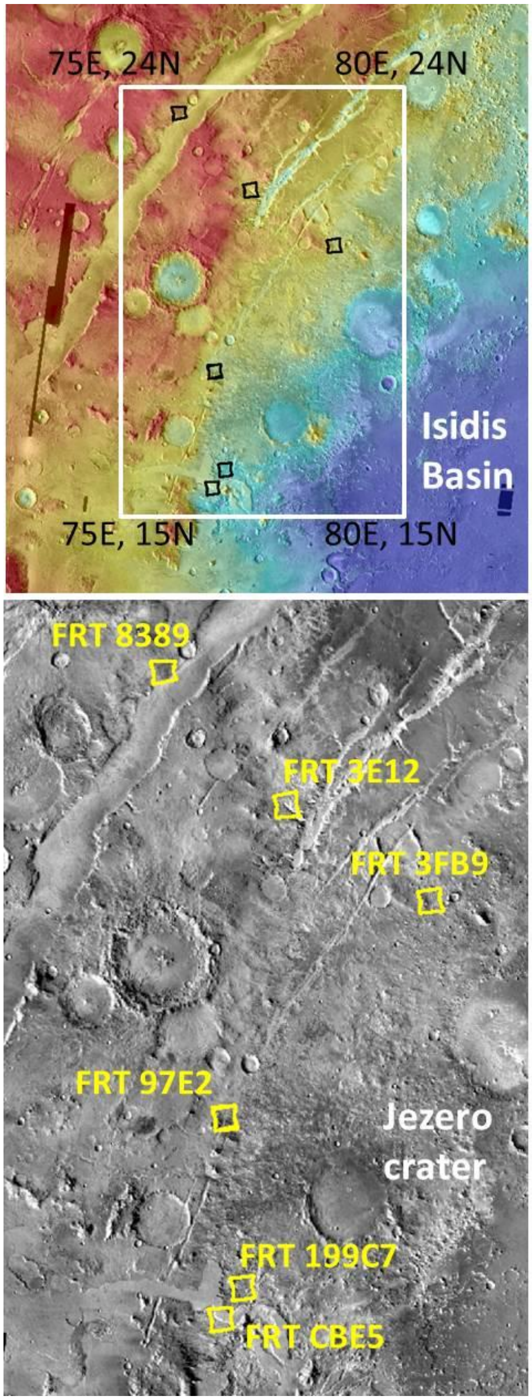
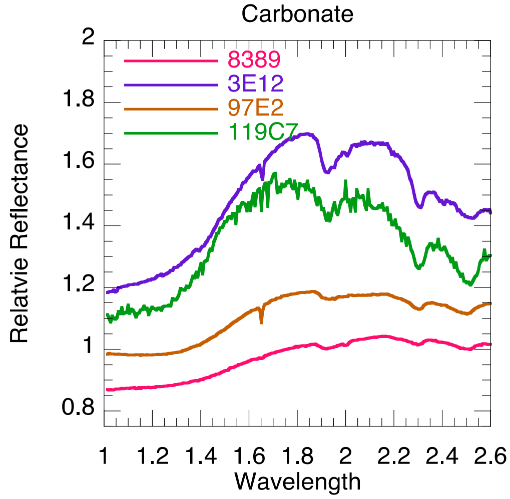


Figure 1. (upper) MOLA color coded topography on THEMIS day IR map. (lower) Zoom in of white box showing CRISM footprints covering north-south transect of high and low elevations from which spectra were extracted (Figure 2).

This analysis focuses on CRISM observations FRT00008389, FRT00003E12, FRT000097E2, and FRT000119C7, referred to subsequently by the last alphanumeric designation, that comprise a transect from north of Nili Fossae at an elevation of -0.2 km to the most southerly point at -2.4 km (Figure 1). In addition, the morphologic evidence of hydrologic activity changes from the north where evidence of fluvial geomorphic features (e.g. channels) is sparse to the south where there is the Jezero open basin lake [11,12] and where fluvial channels are observed on the eastern border of Syrtis Major [13]. For each observation representative spectra of olivine, phyllosilicate and carbonate were extracted for analysis. These spectra are compared across the transect (Figure 1) to address outstanding questions regarding carbonate formation.

Results: The relationship between the rock units, alteration signatures, and the fluvial features show a distinct trend. Throughout the transect phyllosilicate and olivine spectral signatures are comparable in strength. Carbonate signatures however very in association with fluvial features. In the northernmost and highest elevation site (8389) (Figure 1) the carbonate feature is weak (Figure 2). Similarly, in scene 97E2 where there are comparably few fluvial features, carbonate signatures are weak (Figure 2).

For scene 3E12 (Figure 1), which is transected by a fluvial channel, the carbonate signature is relatively strong but contaminated by phyllosilicate absorptions shown by the small feature at 2.4 µm (Figure 2). In scene 119C7, which covers the lowest elevation and is in the area with the most abundant fluvial features, the carbonate feature is strongest. Furthermore, the relative strengths of the 2.3 and 2.5 µm bands are reasonably comparable, which is more consistent with what is expected from analysis of terrestrial spectra.



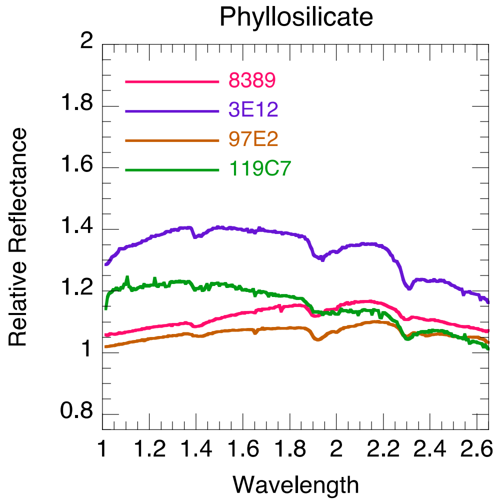


Figure 2. (upper) Carbonate spectra from CRISM FRTs shown in Figure 1. (lower) Phyllosilicate spectra from CRISM FRTs shown in Figure 1.

Implications: The overall goal of this work is to assess possible environments of carbonate formation from subsurface serpentinizing systems to near-surface or surface weathering environments. The correlation of carbonate absorption band strength with apparent density of fluvial features shown here would suggest a near surface or surface environment with surface water playing a role. Future work will quantify the complete variability of mineral absorption characteristics, with a focus on relationships among unaltered (olivine) and altered (phyllosilicate and carbonate) rocks that are well exposed in NE Syrtis.

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