REFINING MARTIAN CARBONATE CHEMISTRIES DETERMINED THROUGH CRISM ANALYSES OF SEVERAL CARBONATE-BEARING OUTCROPS. J. L. Bishop[1] , J. J. Wray[2], B. L. Ehlmann[3], A. J. Brown[1], and M. Parente[4], [1]SETI Institute & NASA-ARC (Mountain View, CA, jbishop@seti.org), [2]Georgia Tech, (Atlanta, GA), [3]JPL/Caltech (Pasadena, CA), [4]Univ. of Massachusetts (Amherst, MA).

Introduction: Carbonates have been identified on Mars in several locations. The objective of this study is to provide constraints on the carbonate chemistry through CRISM analyses using new laboratory spectra of carbonates with a variety of chemical compositions. Our results indicate that carbonates observed near the Isidis Basin and Mawrth Vallis have higher levels of Mg, while carbonates found at other sites are more consistent with Ca-bearing carbonates.

Background: Recent studies have identified carbonates at Nili Fossae [1,2], Libya Montes [3], the Phoenix landing site [4-5], and several craters: Gusev [6-7], Leighton [8], Huygens [9], and McLaughlin [10]. At the Nili Fossae and Libya Montes sites bordering Isidis Basin the carbonates are mixed with phyllosilicates and olivine or are located near them and thus the spectral properties of all three minerals are frequently present together [1,3]. Figure 1 shows an example of carbonate-bearing outcrops at Libya Montes.

Carbonates are identified in CRISM spectra by paired bands near 2.3 and 2.5 µm. Detection of an additional band near 3.4-3.5 µm provides confirmation of the carbonate assignment, although this band is frequently weak and difficult to observe in CRISM spectra. New laboratory spectra of several natural and synthetic carbonates have been measured [11] and provide additional data for constraining the chemistry of carbonates on Mars.

CRISM data: CRISM images were selected for this study based on previous detections of carbonate-bearing outcrops [1,3,8,9,10]. TRR3 calibration versions were used in this study and spectra were ratioed in column for 3x3, 5x5 and 10x10 pixel regions. Spectra are shown in Figure 2 for five example sites in the study. The increased slope from 1.2-1.8 µm in the Nili Fossae and Libya Montes spectra are typical of Fe-bearing carbonates [e.g. 11] but could also be due to olivine. Although the bands in the 3.4-3.5 µm region are weak and poorly resolved, a trend is observed for

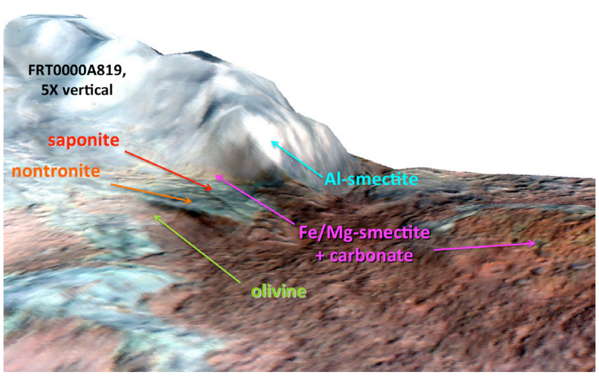

Figure 1. Location of carbonate-bearing rocks in image FRT0000A819 at Libya Montes [from 3]. Carbonates are found together with Fe/Mg-smectites here.

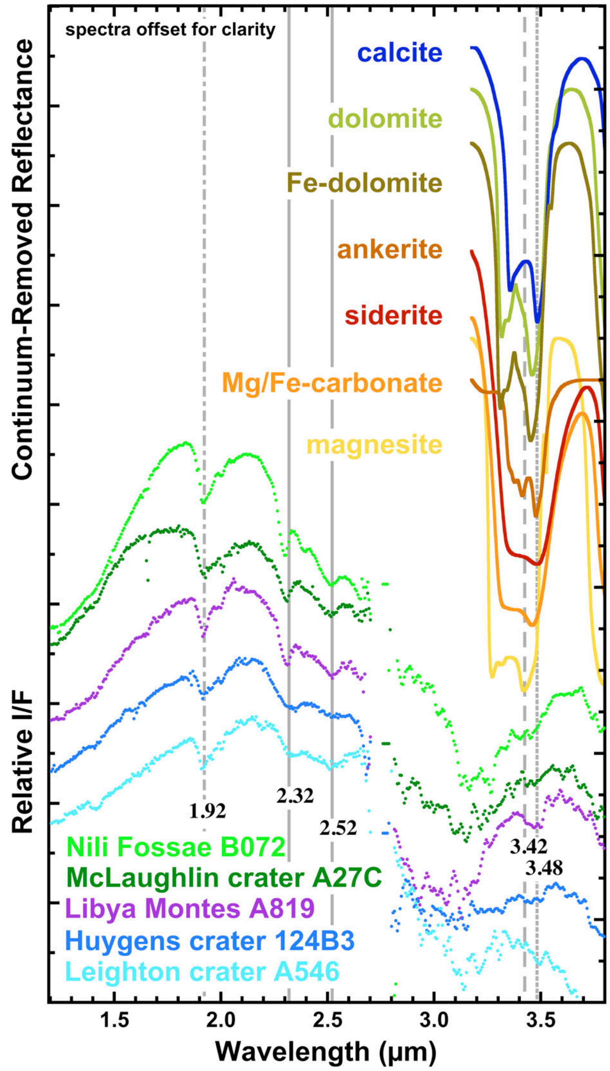

Figure 2. Relative CRISM I/F spectra of carbonate-bearing regions on Mars from images FRT0000B072, FRT0000A27C, FRT0000A819, FRT000124B3, and FRT0000A546 compared with continuum-removed lab spectra of natural and synthetic carbonates from [11]. Each of the Mars spectra contains bands near 2.3, 2.5 and 3.4-3.5 µm attributed to carbonate, plus a band at 1.92 µm due to a hydrated component. The dashed line at 3.42 µm marks the magnesite band, while the dotted line at 3.48 µm marks the calcite band.

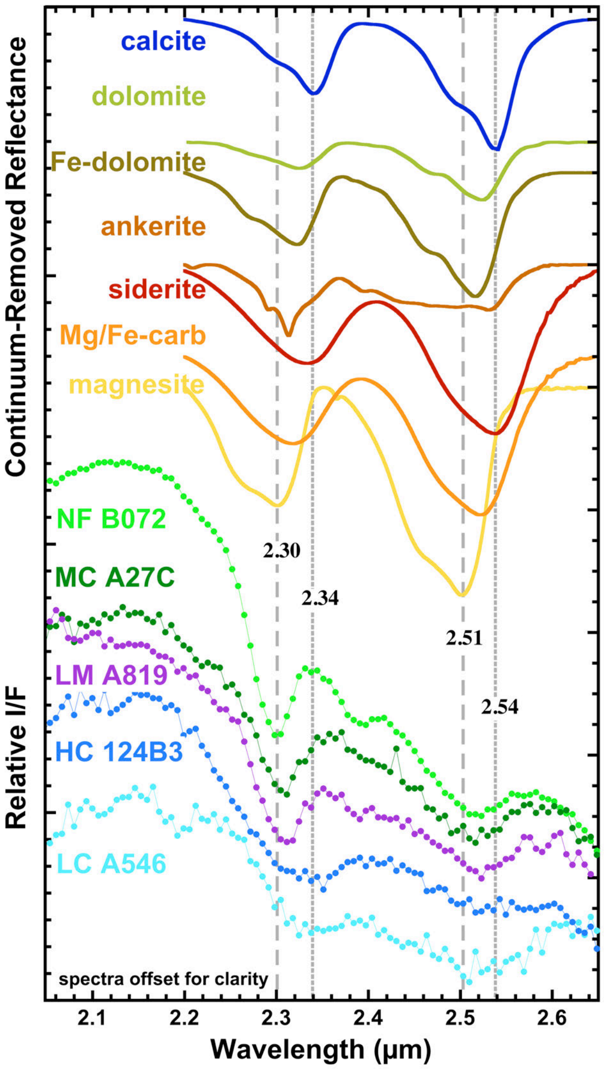

Figure 3. Relative CRISM I/F spectra of carbonate-bearing regions on Mars as in Figure 2 compared with continuum-removed lab spectra of natural and synthetic carbonate samples from [11]. The dashed lines at 2.30 and 2.51 µm refer to the magnesite bands, while the dotted lines at 2.34 and 2.54 µm refer to the calcite bands.

these data such that the band occurs at shorter wavelengths in the Nili Fossae and McLaughlin crater (at Mawrth Vallis) spectra and at longer wavelengths in the Huygens crater and Leighton crater spectra.

CRISM spectra are shown from 2.1-2.6 µm for these five sites in Figure 3. These data show that the band centers near 2.3 and 2.5 µm in the CRISM data do not line up in a straightforward manner with typical carbonate compositions. This could be a result of mixing of the carbonates with other components. In order to coordinate the Martian carbonate data with carbonate chemistries, a band center plot is shown in Figure 4. These data illustrate that the Nili Fossae carbonate is

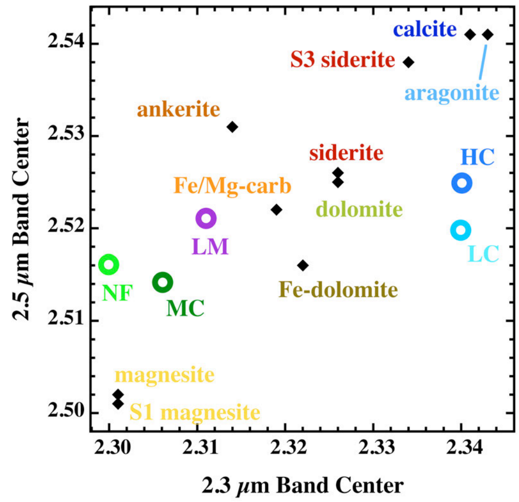

Figure 4. Carbonate band center comparison for the 2.3 and 2.5 µm bands. Values determined from the continuum-removed spectra.

most closely related to magnesite, the McLaughlin crater and Libya Montes carbonates are more similar to Fe/Mg-carbonate and Fe-dolomite, and the Huygens crater and Leighton crater carbonates are most similar to Ca-rich carbonates. Although the band positions for the Huygens crater and Leighton crater carbonates fall in between the values for siderite and calcite/aragonite, Fe-rich carbonates are unlikely explanations of these data because of the shape of the Huygens and Leighton carbonate spectra at shorter wavelengths. Even small amounts of Fe in carbonate cause a band near 1 µm that would be seen in these spectra if Fe were present.

Another factor that influences the position of the carbonate bands near 2.3 and 2.5 µm is the presence of phyllosilicates. Fe/Mg-smectites exhibit a band near 2.3 µm and a study of nontronite/magnesite mixtures has shown that a small amount of nontronite disproportionally influences the position of the 2.3 µm band in these mixture spectra [12]. Serpentines have also been found associated with the carbonates at Nili Fossae [13] and phyllosilicates such as serpentines could be influencing the band position and shape near 2.5 µm.

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