CARBONATE ASSOCIATED WITH GULLIES IN THE ERIDANIA REGION OF MARS

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Introduction: Carbonate occurrences and deposits on Mars are limited in volume and location. Regional carbonate bedrock deposits on Mars have been identified using CRISM in Noachian aged rocks in the Nili Fossae region [1] and Libya Montes [2] and exposed within and/or in the vicinity of Leighton Crater [3], Huygens crater [4], McLaughlin crater [5] and in a crater near Tyrrhena Terra [6]. Here we recognize another occurrence of carbonate within a crater in the Eridania region of Mars.

Geologic setting. The carbonates are found in an unnamed crater ~61 km across located at 37.07°S, 178.23°W (Fig. 1). Gullies are common on the pole-facing slopes of this crater. Viscous flow features are observed along the crater wall, within and between gully alcoves and channels, and as protalus ramparts at the foot of gullies. Multiple generations of viscous features also cover the crater floor. The NE wall contains a set of fresh- appearing gullies that show multiple generations of flow as evidenced by numerous tributaries and coalescing fans. The carbonate signature is associated with a number of these fresh gullies; the signature is found within some gully alcoves and is very obviously correlated to the fans of the same gullies. This suggests a source that is localized, providing materials to some gullies and not others. Some of the carbonate material is being transported and distributed by the gullies which requires a consistent source of carbonate-bearing rocks over the time it takes to build a complex alluvial fan at the base of the gullies. The carbonate signature is also present in viscous flow materials that lie beyond the toe of and stratigraphically below the most recent fans associated with the largest gully system. If we assume that these viscous flow materials incorporated materials from the gully upstream, this implies an even longer time frame for carbonate delivery through the system onto the crater floor.

HiRISE images show that there is resistant layer at the top of the crater wall (rim crest) exposed on the NE side of the crater. Many of the gullies containing carbonate intersect this layer. In several cases, it appears that the carbonate signature can be traced directly to a particular outcrop. This and the association of the carbonate with the fans support the hypothesis that the gullies are eroding carbonate-bearing rocks exposed by the crater. The crater is mapped to lie within Noachian-aged materials [7]. The discovery of other exposures of carbonate-bearing rocks in this region would further support this idea.

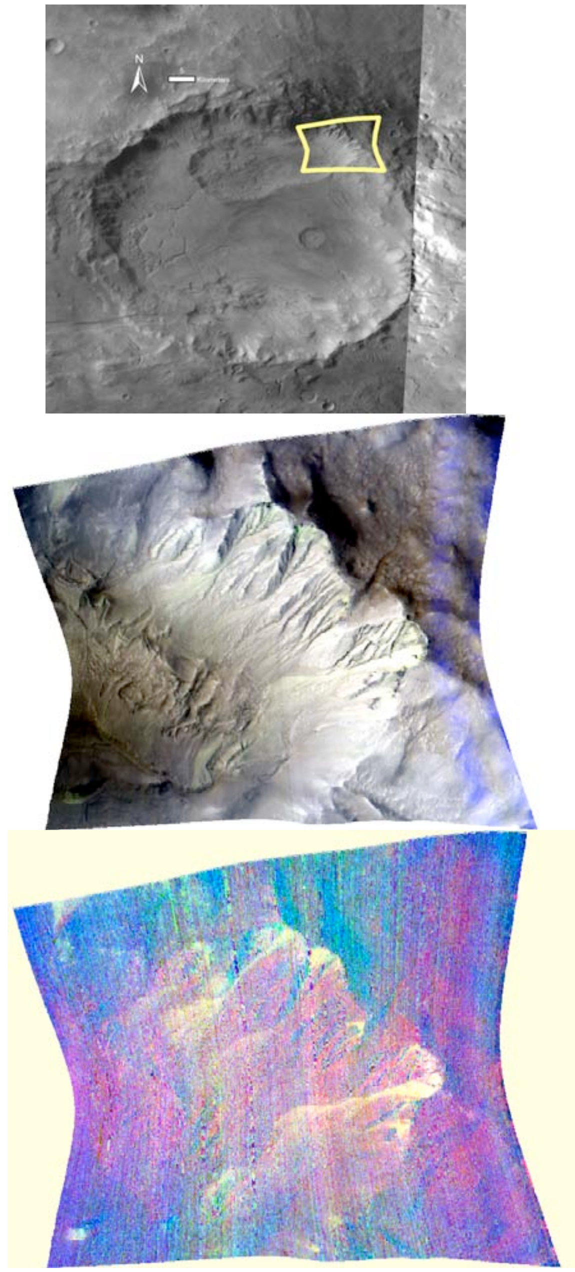

Figure 1. CRISM image 120de. (top) location image on HRSC background. (center) RGB = 2.40 µm, 1.82 µm, 1.18µm; carbonates appear green in this image. (bottom) RGB = OLINDEX, D2300, BD2500 [1, 10]. Carbonates are pale yellow in this image.

CRISM Analysis. Minerals were identified in data from the CRISM instrument aboard MRO. The data were converted to I/F and atmospheric correction and noise removal were applied using CAT 7.2.1. Spectra of interest were identified and ratioed to spectrally neutral regions in the same scene column to further reduce instrument and atmospheric noise.

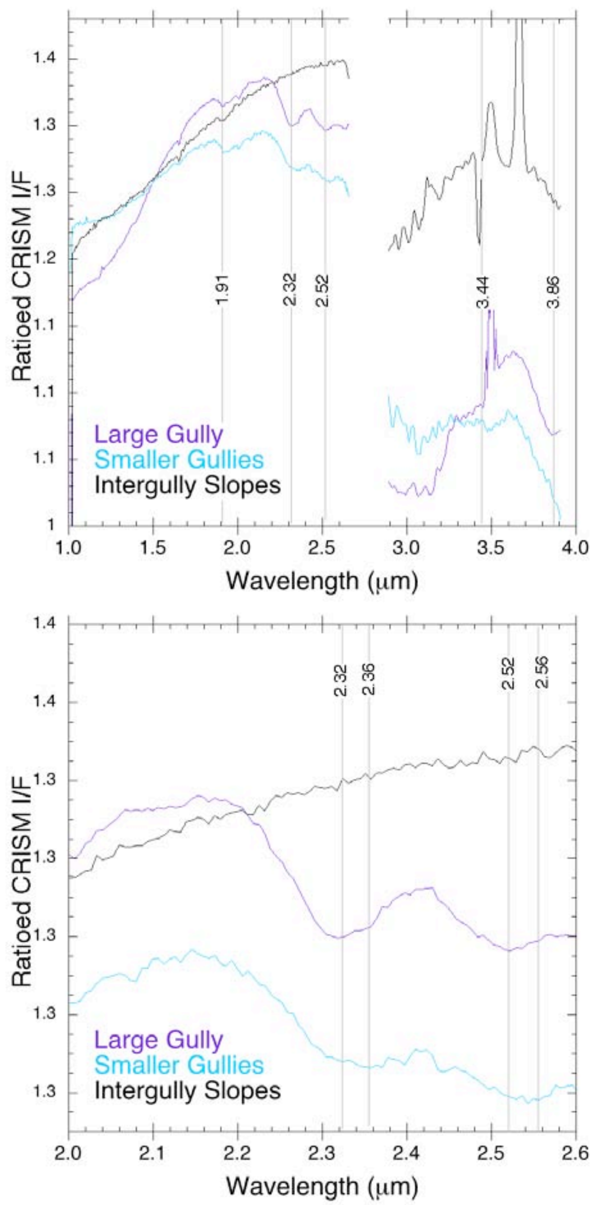

Figure 2. Ratioed spectra of regions in FRT 120de. Spectra are offset for clarity.

Spectra derived from three locations along the crater wall display absorptions at 2.3, 2.5, 3.47 and 3.86 μm, a broad band at ~1 μm and a weak absorption at 1.91 μm. The 2.3, 2.5, 3.4 and 3.9 μm absorptions are typical of anhydrous carbonates [8] and some Mg-OH bearing hydrous carbonates [9]. The 1 μm feature is typical of ferrous minerals and is consistent with the carbonate siderite, or by an admixture of Mg or Ca carbonates with ferrous minerals. The 1.9 μm feature may indicate admixture of anhydrous carbonates with hydrous minerals. The 2.3, 2.5, 3.4, 3.9 and 1.9 μm features are present in the hydrous carbonate hydromagnesite ($Mg_5(CO_3)_4(OH)_2{\cdot}4H_2O$), but the strength of these features is diminished relative to anhydrous carbonates and other water absorptions at 1.2 and 1.4 μm are not observed. Both magnesite ($MgCO_3$) and hydromagnesite can display a 1 μm feature if some Fe substitutes for the Mg in the crystal lattice.

The 2.3 and 2.5 μm features are broad and vary slightly by location. Carbonates detected within the largest gully in the scene display absorption band centers at 2.31 and 2.52 μm, which is consistent with magnesite [e.g., 1,3]. Spectra from within the smaller gullies have absorptions a slightly longer wavelengths 2.36 and 2.54 μm. These band center positions are more typical of siderite ($FeCO_3$), calcite ($CaCO_3$) or dolomite ($CaMg(CO_3)_2$) [e.g., 1,3]. The broad nature of the 2.3 and 2.5 μm in these spectra as compared to library endmember mineral spectra suggest that these carbonates are mixtures of carbonates of varying composition. This is consistent with the fact that the 2.3 μm feature in the large gully displays a shoulder feature at 2.36 μm. The spectra in Eridania could be explained by a mixture of Mg, Fe, and Ca carbonates or by (Mg, Fe) carbonates with varying Mg,Fe ratios.

The remainder of the CRISM scene is spectrally unremarkable. Spectra of the areas on the slope between the gullies have a weak 1.9 μm feature. All materials that display a 2.3 μm feature also have the 2.5 μm absorption. No other minerals have been positively identified in the region. This makes this carbonate occurrence differ from all other ancient regional deposits found to date. In other regions, the carbonates are associated with Fe/Mg smectites and sometimes also Al- phyllosilicates and/or olivine-bearing units; the correlation with olivine may support carbonate formation via hydrothermal alteration of mafic materials [1-6]. The carbonates in Eridania may indicate different formation conditions than other carbonate deposits.

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