

CHARACTERIZING AQUEOUS AND MAFIC MINERALOGY AT GALE CRATER, MARS WITH NEW HYPERSPECTRAL ALGORITHMS. Mario Parente¹, Arun M. Saranathan¹, Yuki Itoh¹, Janice L. Bishop², Catherine M. Weitz³, ¹University of Massachusetts (Amherst, MA; mparente@ecs.umass.edu), ²SETI Institute (Mountain View, CA), ³Planetary Science Institute (Tucson, AZ).

Summary: Gale crater features abundant outcrops of phyllosilicates, sulfates, and other minerals that are under investigation by Curiosity [e.g. 1] following their observation in CRISM images [2]. These analyses by the rover are enabling ground truthing of minerals identified from orbit, especially those acquired by the CRISM instrument. Recent advances in image processing [3] and hyperspectral mapping [4], coordinated with mineral detections on the surface, are facilitating improved characterization of aqueous and igneous minerals across the Gale crater region. Here we present the results of mapping phyllosilicates, sulfates, other hydrated phases, and pyroxene using CRISM data of Mount Sharp at Gale crater.

Methods: We used the Parente group algorithm for simultaneous atmospheric correction and denoising of

CRISM images in the 1.0-2.6 μm spectral range that removes the majority of the residual atmospheric bands and spurious noise [3]. Several CRISM images have been processed using this technique for the Gale crater region, including images FRT000095EE, FRT000B6F1, FRT0000C0EF, and FRT0000C518 shown in Figs 1-2. We applied a new mapping algorithm using hyperspectral components in the feature extraction to discriminate among spectral types [4]. This technique applies Generative Adversarial Networks (GANs) [5] to learn the diagnostic spectral features needed for discriminating among spectral types using hyperspectral components in the feature extraction, to extend the CRISM mineral parameters developed using a spectral band, ratio, or slope [6]. This new GAN method is highly effective in identifying promising locations in the

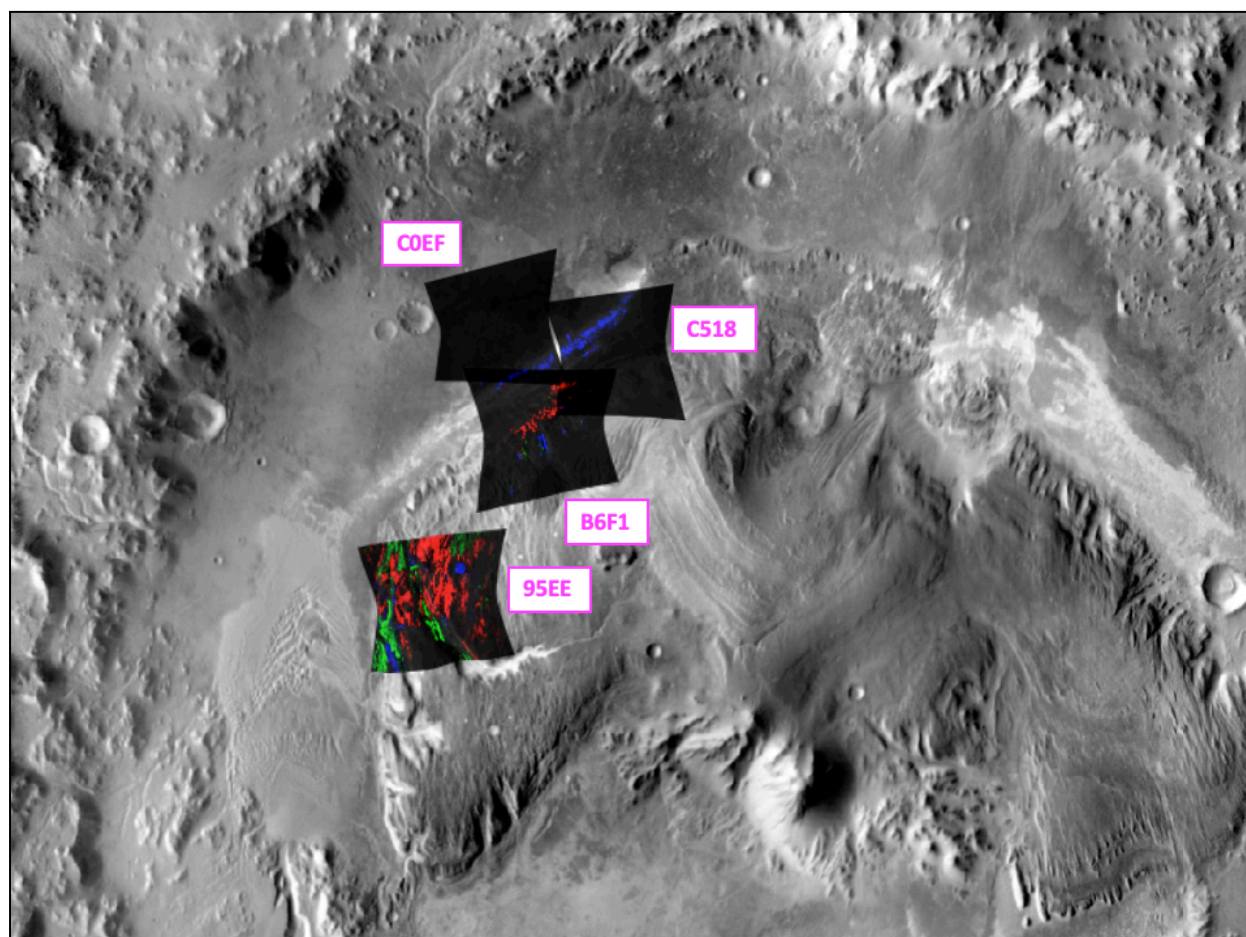


Fig. 1 CRISM mineral maps overlain on a THEMIS daytime image illustrating relationships between sulfates and pyroxene at Gale crater. Polyhydrated sulfates are shown in red, monohydrated sulfates in green, and high Ca pyroxene in blue. Each CRISM image is about 12 km across, and image numbers are given in pink.

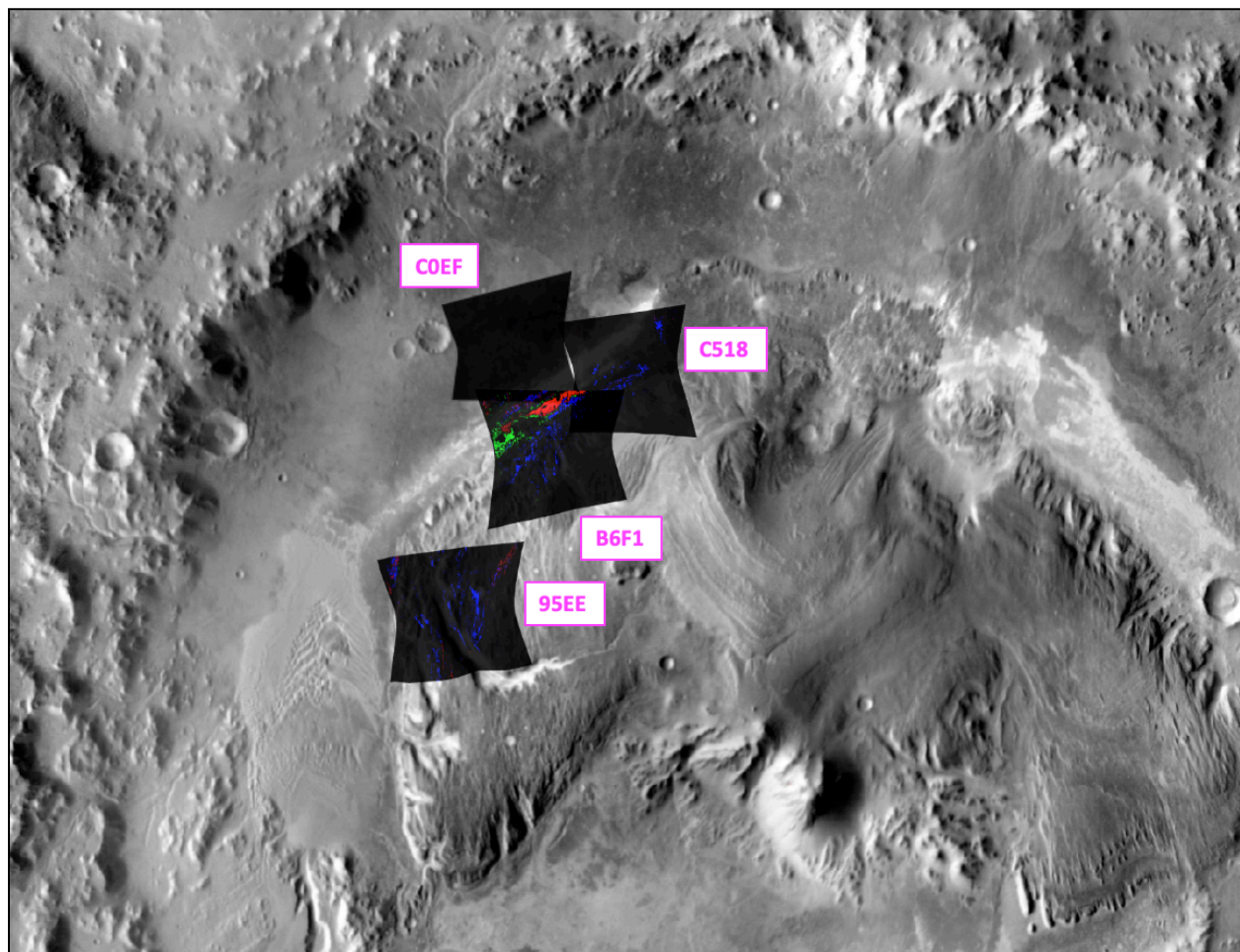


Fig. 2 CRISM mineral maps overlain on a THEMIS daytime image illustrating variations in the phyllosilicate mineralogy and associated hydrated phases observed from orbit at Gale crater. Fe/Mg-smectite outcrops are shown in red, smectite mixture regions in green, and another hydrated phase in blue that is distinct from the phyllosilicates and sulfates observed here. Each CRISM image is about 12 km across, and image numbers are given in pink.

images that contain specific compositional units through the use of machine learning algorithms. Earlier versions of these CRISM images and GAN maps were used recently for evaluating mineralogy across this region [7].

Results: High Ca pyroxene (HCP, blue, Fig. 1) is observed in the marker bed (consistent with [1,7,8]) crossing images C518, C0EF, and B6F1, as well as in smaller outcrops among the polyhydrated sulfates (PHS, red, Fig. 1) and monohydrated sulfates (MHS, green, Fig. 1). Fe/Mg-smectites (red, Fig. 2) occur parallel to the marker bed and between the HCP and PHS outcrops (Fig.1). An additional poorly crystalline smectite-bearing unit (green) extends SW from the Fe/Mg-smectite outcrop, perhaps indicating alteration of these phyllosilicates. Another hydrated phase (blue, Fig. 2) was discovered N and S of the marker bed and in between the PHS and MHS in image 95EE that may indicate hydrated poorly crystalline material.

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