**THEMIS-VIS COLOR AND MORPHOLOGIC INVESTIGATIONS AT GALE CRATER** K. A. Bennett[1], J. R. Hill[2], K. C. Murray[2], C. S. Edwards[1], J. F. Bell III[2] and P. R. Christensen[2], [1]Northern Arizona University, Department of Physics and Astronomy, Box 6010, Flagstaff AZ 86011 (Kristen.Bennett@nau.edu), [2]Arizona State University, School of Earth and Space Exploration, 781 E Terrace Mall, Tempe AZ 85287.

**Introduction:** The Mars Science Laboratory (MSL) rover landing site is within Gale Crater, a ~150 km impact crater located near 5°S, 222°W. As the rover explores the northwest sector of the crater, additional studies that include the entire crater and surrounding terrain are needed to provide the regional context of the landing site. Here we present regional color (Fig. 1) and grayscale (Fig. 2) mosaics of Gale crater using the NASA Mars Odyssey orbiter's Thermal Emission Imaging System Visible Imaging Subsystem (THEMIS-VIS) images. These regional mosaics permit the interpretion of morphologic and color units within and surrounding Gale crater.

**Background:** There have been many studies utilizing orbital observations of Gale [*e.g.*, 1-6]. These studies have shown that the 5-km tall sedimentary mound within the crater exhibits aqueous mineral signatures near its base [*e.g.*, 2]. The stratigraphy within the mound (Mt. Sharp) likely records the evolving ancient martian climate. While the origin of the mound material is still debated, studies have shown that there was likely a lake within Gale crater at some point in its history [6,7].

**Methods:** THEMIS [8] is a multispectral imager on the Mars Odyssey spacecraft with a ten-band mid-infrared microbolometer array and a five-band visible and near-infrared (NIR) interline transfer CCD imager. The visible/NIR camera (THEMIS-VIS) has a resolution of up to 18 m/pix with band centers located at 425, 540, 654, 749 and 860 nm.

For both the color and grayscale mosaics, each THEMIS-VIS image was calibrated using the methods of [9] and were map-projected using the U.S. Geological Survey's Integrated Software for Imagers and Spectrometers, version 3 (ISIS3). The images were contrast stretched following the process used to generate the standard THEMIS-VIS multiband RGB products [10]. The images were then mosaicked using the process and blending algorithms described by [11]. We also used this process to create a THEMIS-IR decorrelaton-stretch (DCS) mosaic (Bands 8/7/5).

**Results:** We identify multiple distinct color units within the false color visible-wavelength mosaic (Fig. 1), including the gray crater exterior and the beige or light pink central mound. The largest color variations in the region occur in the dunes, which range from purple to blue, consistent with the spectral properties of typical Mars mafic materials.

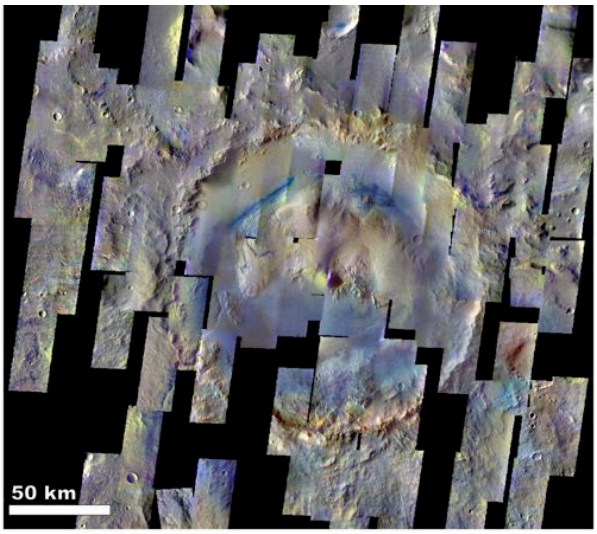


Fig. 1: THEMIS-VIS band 4/2/1 color mosaic of Gale crater

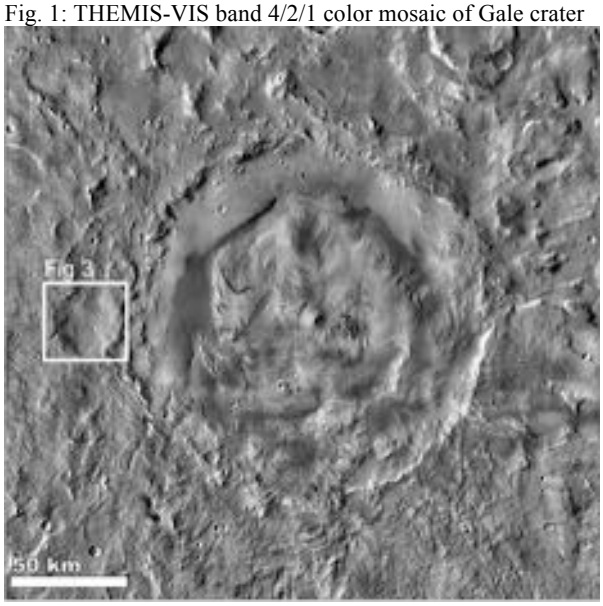


Fig. 2: THEMIS-VIS band 3 mosaic of Gale crater

With the THEMIS-VIS grayscale mosaic (Fig. 2) we have identified many examples of sedimentary deposits in the area surrounding Gale crater, including potential deltaic landforms (Fig. 3), layered sedimentary deposits, channels, and (with additional MRO HiRISE [12] images) small-scale fractures.

Part of the THEMIS DCS mosaic overlain on top of the Band 3 mosaic is shown in Fig. 4. The DCS mosaic shows many distinct color-units and in general matches the morphology well. The top of the central mound appears blue, while the crater floor varies from

green to purple to yellow. Dunes within Gale vary from pink to gold. Previous studies using 8/7/5 DCS mosaics suggest blue corresponds with dust, magenta with mafic material, and yellow with felsic material or sulfates [13].

**Discussion:** There are several color units in the THEMIS-VIS color mosaic, but the mound is typically the same color. The largest color variation on the mound are small blue patches, which HiRISE images reveal are small piles of sand that have accumulated on bedding surfaces. The dunes on the crater floor vary in THEMIS-VIS color as well as in the DCS mosaic. The dunes in the NW are bluer in VIS false color than the western sand sea, which might suggest the sand sea is dustier. However, the NASA Mars Global Surveyor mission's Thermal Emission Spectrometer (TES) [14] dust cover index shows that the sand sea is likely less dusty than the NW dunes. We will constrain the thermal inertia and mineralogy of these dunes to test whether this difference is due to grain size or compositional differences.

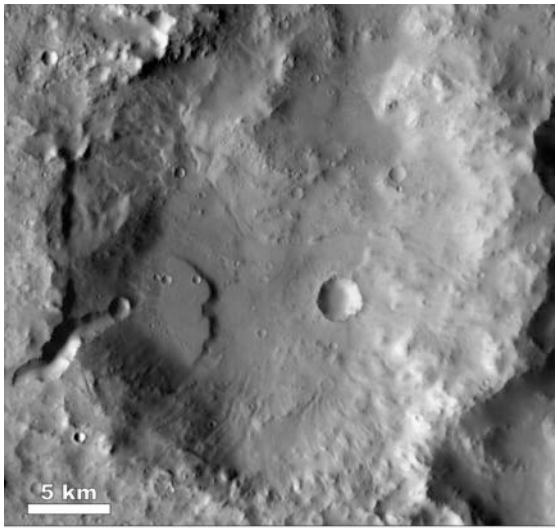


Fig 3: THEMIS-VIS Band 3 mosaic. A channel and potential deltaic feature in a crater located to the west of Gale crater.

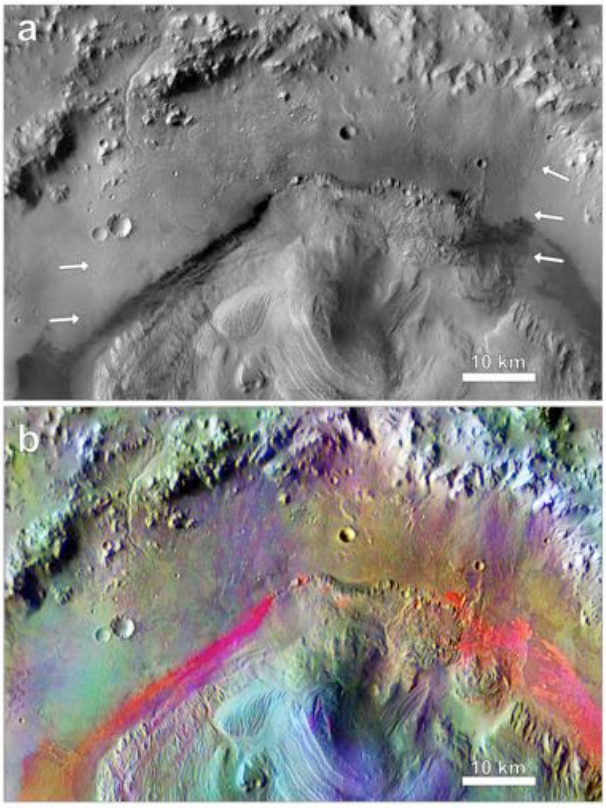


Fig 4: a) THEMIS-VIS Band 3 mosaic of the northern half of Gale crater. b) THEMIS-IR DCS mosaic overlain on top of (a).

The DCS color differences on the crater floor could be due to multiple units on the floor. For example, purple might correspond to debris or fans that have eroded off the crater wall. The green and yellow units could be stratigraphically separate units that extend into or under the central mound. There are morphologic features that support this hypothesis. The arrows in Fig. 4a show the contacts between potential units where the morphology abruptly changes.

In addition to the many sedimentary features within Gale crater, there are sedimentary deposits in the region surrounding Gale. This implies that the geologic processes that created sedimentary deposits within Gale crater were likely operating on larger regional scales and contributed to the creations of sedimentary deposits outside the crater as well.

**Summary:** We created THEMIS-VIS color and grayscale mosaics plus THEMIS-IR DCS mosaics of Gale crater. There are multiple color units in the THEMIS-VIS false color mosaic within Gale crater (although the mound is generally uniform). Dune fields across Gale vary in color in the THEMIS-VIS color mosaic and the DCS mosaic, which could be a result of variations in grain size or composition. Generally, variations within the DCS mosaic correlate with the morphology. We have identified sedimentary deposits in the area surrounding Gale crater that are similar to the sedimentary deposits within Gale.

**References:** [1] Anderson and Bell (2010) *Mars*, 5, 76-128; [2] Milliken et al. (2010) *GRL*, 37, L04201; [3] Hobbs et al. (2010) *Icarus*, 210, 102-115; [4] Thompson et al. (2011) *Icarus*, 214, 413-432; [5] Lane and Christensen (2013) *GRL*, 40, 3517-3521; [6] Le Deit et al. (2013) *JGR*, 118, 2439-2473; [7] Grotzinger et al. (2014) *Science*, 343; [8] Christensen et al. (2004) *SSR*, 11-, 85-130; [9] McConnochie et al. (2006) *JGR*, 111, E06018; [10] Murray et. al. (2016) PDS; [11] Edwards et al. (2011) *JGR*, 116, E10008; [12] McEwen et al. (2007) *JGR*, 112, E05S02; [13] Hamilton *et al.* (2007) *LPSC* #1725; [14] Christensen et al. (2001) *JGR*, 106, 23823-23871.