RECENT RESULTS AND FUTURE PLANS FOR THE PEACE VALLIS CAMPAIGN INCLUDING CHEMCAM RMI SUPER-RESOLUTION OBSERVATIONS.

Z. E. Gallegos[1], H. E. Newsom[1], L. A. Scuderi[1], O. Gasnault[2], S. Le Mouélic[3], K. W. Lewis[4], J. Van Beek[5], R. C. Wiens[6], S. E. Johnstone[6], N. Mangold[3], N. C. Taylor[7] and others. [1]Univ. of New Mexico, Dept. of Earth and Planetary Science, Albuquerque, NM, 87106 (zeg@unm.edu); [2]Institut de Recherche en Astrophysique et Planétologie (IRAP), Toulouse, France; [3]CNRS, Université de Nantes, France; [4]Johns Hopkins Univ., Baltimore, MD; [5]Malin Space Science Systems Inc., San Diego, CA; [6]Los Alamos National Laboratory (LANL), Los Alamos, NM; [7]Univ. of California SC, Santa Cruz, CA.

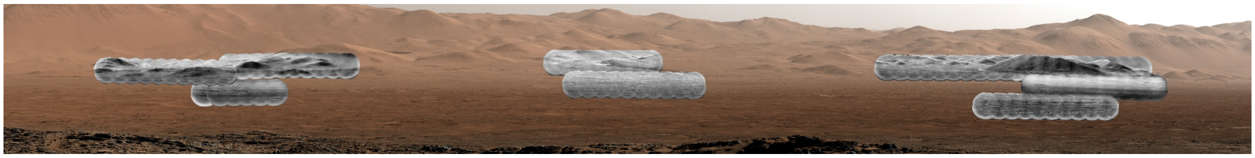

Figure 1. Current ChemCam long-distance Remote Micro-imager coverage over the Peace Vallis fan and associated features.

Introduction: Gale crater displays a long history of fluvial and lacustrine processes which can be inferred from geomorphic and geochemical evidence [1,2]. The Peace Vallis fan is an example of a large geomorphic feature with characteristics that resemble terrestrial alluvial fans formed by fluvio-alluvial processes [3]. Based on cratering statistics, the fan formed during the Hesperian in two distinct pulses when the climate on Mars was conducive to surface water flow and high sedimentation rates [4]. Initial geologic investigations of the fan were conducted [3,5], but subsequent rover observations allow for further analysis. Unresolved scientific issues include: the formation mechanisms for inverted channel development, where processes can range from fluvial deposition to aeolian infilling of channels; potential aerial/sub-aerial interactions with the crater lake; evidence for groundwater springlines as seen in terrestrial analogs; and the sedimentary nature of fan progression, being potentially lobe forming, sheet-flood forming, or a combination of the both.

The Peace Vallis campaign (PVc). The PVc is a Mars Science Laboratory rover imaging campaign directed at understanding the nature and evolution of the Peace Vallis fan through image analysis. The rover instruments involved in the campaign include the ChemCam Remote Micro-imager and Mastcam. The orbital instruments involved in the campaign include the HiRISE and CTX instruments aboard the Mars Reconnaissance Orbiter.

ChemCam Remote Micro-Imager: The mast unit of the ChemCam instrument includes a Remote Micro-imager (RMI) for visual documentation. The RMI is also used for geomorphic and textural investigations beyond 7 m and is the highest resolution camera on the rover used for remote sensing purpose. [6,7]

Mastcam: The narrow-angle Mastcam camera acquires high-resolution, color images useful for long-distance analysis. It also contains a set of filters for multi-spectral imaging [8].

Long distance capability: The RMI was originally designed for confirming the location of ChemCam laser pits and standalone imaging in close proximity to the rover; however, it is now also utilized as a long-distance imager when focused at infinity [9]. Current ongoing targets for long distance RMI observations include the Peace Vallis fan, Aeolis Mons, Gale crater rim, and other medium to long-distance targets.

Super-resolution capability: Image quality may be enhanced through a process called super-resolution, where sub-pixel variations in consecutive images can be processed to increase the apparent resolution of an image. This technique has been initially tested with both with the RMI and the Mastcam.

Long distance RMI PVc Observations: There have been ten long distance RMI rasters acquired on the Peace Vallis fan (**Figure 1**). These observations were obtained earlier in the mission between sols 1237 & 1462 at ~ 3.2-3.7 km away from the rover's current location, with a ~ 270 m change from the rover's current elevation.

ChemCam Super-resolution PVc Test: On sol 1928, an initial test of the ChemCam RMI super-resolution observation capability was performed on the Peace Vallis fan as part of the PVc. This observation (SR-RMI-sol1928) was targeted ~ 11 km from the rover on the lower fan area where linear, raised features have been interpreted as inverted channels. The test image shows a definite increase in the apparent resolution of RMI capability with significantly less noise and image artifacts. Overall, both small-scale and large-scale features become more apparent with the super-resolution imaging technique.

PVc GIS Techniques: To fully understand the relation of features in rover-view and orbital-view, the PVc includes GIS analysis using the RMI, Mastcam, HiRISE, and CTX (**Figure 3**). Currently, four ChemCam RMI mosaics have been successfully matched to HiRISE imagery using ArcMap and ArcScene projection methods (**Figure 4**). These include one RMI mosaic from sol 1241, two from sol 1257, and one from sol 1300. Analysis of inverted HiRISE DTMs on the fan allowed for reconstruction of the inverted channel network.

Future PVc Plans: A new phase of the PVc has begun and will include new rover observations and GIS analysis. This proposed dataset will complete the information necessary to fully understand the Peace Vallis fan and associated features.

PVc objectives. The PVc has established minimum objectives and goals for the campaign, including: 1) ChemCam RMI super-resolution observations on priority features, 2) complete ChemCam RMI coverage of the fan, 3) complete Mastcam super-resolution coverage of the fan, 4) GIS analysis to correlate rover-view and orbital-view observations.

ChemCam long distance RMI. Currently, the Peace Vallis fan has limited coverage with the ChemCam RMI. To fully understand the nature and evolution of the fan complete RMI coverage of the fan and the surrounding areas is necessary. Previous RMIs on the fan were acquired from a different angle and elevation than the rover's current vantage point. This variation in perspective will aid in understanding the features if future RMI rasters overlap past rasters.

ChemCam RMI super-resolution. The initial test for RMI super-resolution shows a potentially valuable observation type as the highest resolution long distance imager on Mars. Four priority areas have been identified for observations in the PVc: 1) the edge-on face of inverted channels, 2) upper fan channel near the crater rim, 3) eroded ancestral fan buttes, 4) small boulders distributed on the fan. Detailed analysis of these features will provide clues to the depositional environment, sedimentation characteristics, and general evolution of the fan.

Mastcam observations. Mastcam M100 coverage of the Peace Vallis fan is necessary to provide context for long distance RMI observations. Mastcam super-resolution will provide even higher detail context for ChemCam super-resolution observations. The PVc also seeks to obtain limited multispectral observations to discern between sedimentary layers and other structures at high priority sites.

GIS techniques. GIS analysis will continue to be an important component of the PVc. Projecting RMI images on HiRISE images to correlate geologic features as well as analysis of features in rover and orbital imagery will aid in understanding the fan.

Conclusion: The PVc imaging campaign aims to complete ChemCam RMI and Mastcam super-res coverage of the Peace Vallis fan. Long distance RMI observations, including the new super-resolution imaging technique, will provide small scale detail needed to map the sedimentary features of the fan. These rover observations, in conjunction with orbital observations, will shed light on the geologic nature and evolution of Gale crater and the Peace Vallis fan.

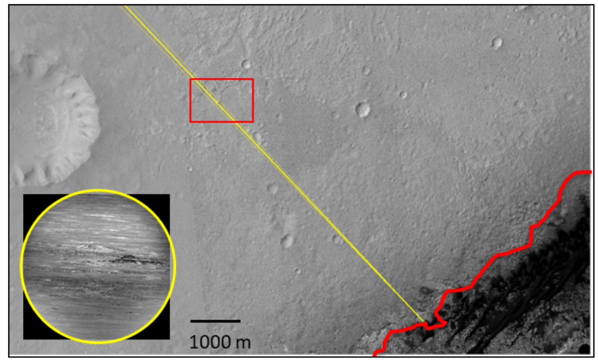

Figure 3. Long distance RMI observation on sol 1237 of the Peace Vallis fan. Field of view sector projected in yellow.

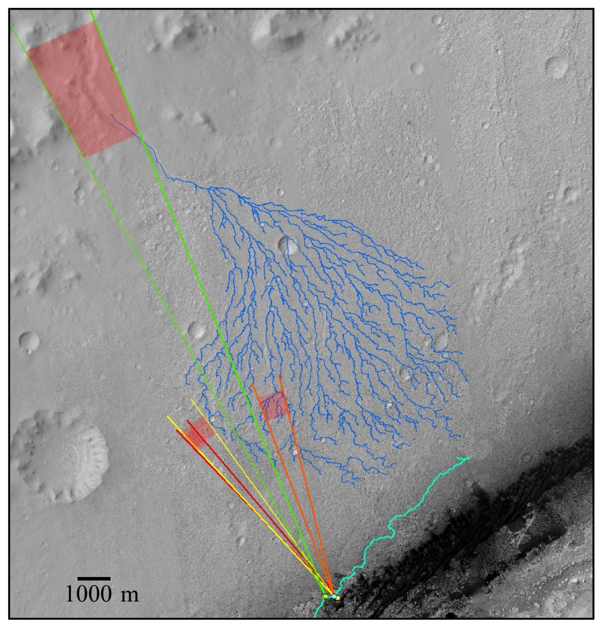

Figure 4. RMI coverage of a reconstructed inverted stream network (inverted channels) created from HiRISE DTM on the Peace Vallis fan. The colored sectors represent individual RMI rasters: sol 1241 = red, sol 1257 = orange, sol 1257 = yellow, sol 1300 = green. The red segments within each RMI sector indicate the approximate surface visible in the image.

References: [1] Grotzinger J. P. et al. (2013) Science, 343, 6169, 1242777. [2] Grotzinger J. P. et al. (2015) Science, 350, 6257, aac7575. [3] Palucis M. C. et al., (2014) *JGR, 119,* 705–728. [4] Grant J. A. et al. (2014) GRL, 41, 1142-1149. [5] Sumner D. Y. et al. (2013). [6] Maurice S. et al. (2012) Space Science Rev., 170, 95-166. [7] Maurice S. et al. (2009) *LPSC XL,* #1864. [8] J. F. Bell et al., (2012*) LPSC XLIII*, #2541 [9] Le Mouélic S. et al. (2015) Icarus*, 249,* 93-107.