GLOBAL DISTRIBUTION OF STRATIFIED DEPOSITS ON MARS. K M. Stack[1], J. P. Grotzinger[1], R. E. Milliken[2], R. N. Farley[3] [1]California Institute of Technology, Pasadena, CA 91125 (kstack@caltech.edu), [2]Brown University, Providence, RI 02912, [3]Vassar College, Poughkeepsie, NY 12604.

Introduction: A wealth of information is recorded in the geometry and physical characteristics of stratified rocks. In situ and orbital observations of the Martian rock record have shown that stratification is as fundamental a characteristic of the rock record on Mars as it is on Earth [1-4]. The widespread coverage of high resolution images, such as those from the Mars Reconnaissance Orbiter (MRO) High Resolution Imaging Science Experiment (HiRISE), now provides an opportunity to gain insight into the past processes that controlled sediment transport and deposition on Mars.

Several previous studies have used orbital observations on a global scale to understand the stratigraphic record of Mars [3-8]. This study uses the highest resolution images available of the Martian surface obtained by HiRISE to create a global inventory of stratified deposits on Mars. Deposits are classified according to geomorphic setting and the age of the terrain in which the deposits occur. The goal of creating such an inventory is to better understand the diversity and relative importance of various depositional processes through time and across the surface of Mars.

Methods: HiRISE images were obtained from the HiRISE website (http://hirise.lpl.arizona.edu), and were viewed using the HiView application. 17,120 HiRISE images acquired between September 2006-January 2013 within the latitude range of 60 degrees north and south of the Martian equator (polar regions excluded) were inspected for the presence of stratified deposits (Fig. 1a, b). Calibration images, dust-obscured images, and duplicate images (i.e. stereo-pairs) were removed from the database.

Each image was evaluated by visual inspection for evidence of stratified bedrock. Stratification was identified in gray-scale orbital images by systematic alternations in brightness that were continuous on a scale of tens of meters or more, or by distinct shadowed shelf-like topographic breaks in slope. If images contained a stratified deposit(s), the deposit(s) was then categorized by geomorphic setting as: crater interior, canyon/chasm/chaos interior, channel interior, inter-crater/canyons planes, or other (e.g. crater ejecta or volcanic constructs) (Fig. 1c). Deposits were also classified by type within a particular setting. For example, deposits falling into the "crater interior" category were further subdivided into mounds, fills, central uplifts, or crater walls. This classification allowed deposits to be grouped as "basin-fill" or "wall/uplift" deposits (Fig. 1d). Basin fills broadly represent depositional processes influenced by topography, whereas wall/uplift deposits were likely deposited by processes not controlled by topography at the length-scale of individual crater or canyon basins. This procedure was repeated with each image, with the classification tags tabulated in an Excel spreadsheet.

The inventory of stratified deposits was then plotted in ArcGIS on a THEMIS DAY IR/MOLA base map. In order to examine depositional trends over time,

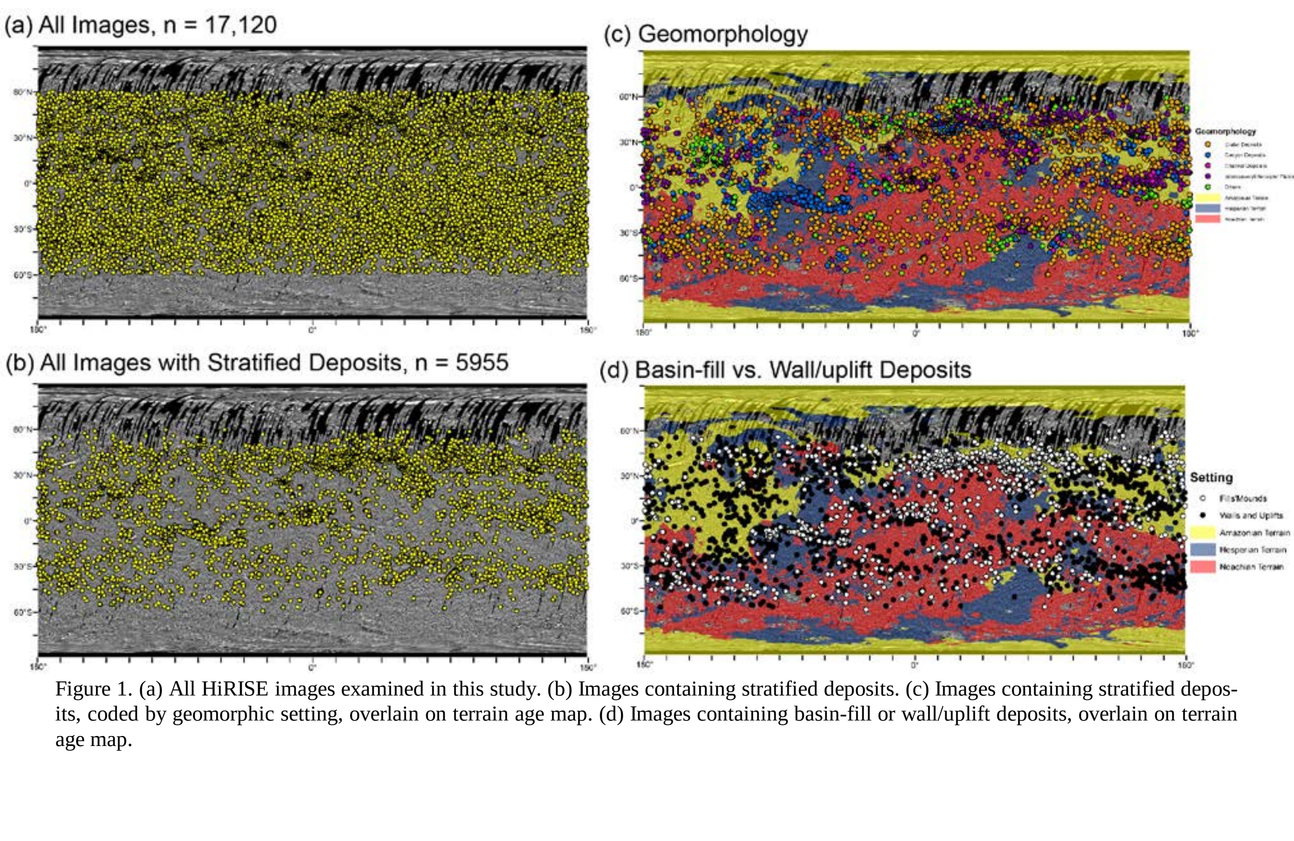

Figure 1. (a) All HiRISE images examined in this study. (b) Images containing stratified deposits. (c) Images containing stratified deposits, coded by geomorphic setting, overlain on terrain age map. (d) Images containing basin-fill or wall/uplift deposits, overlain on terrain age map.

the global distribution of Noachian, Hesperian, and Amazonian-aged terrains from Mars Global Geologic Map 1802ABC [9] was used in ArcGIS to subset the stratified deposit inventory according to the age terrain in which the deposits occur. Results are presented in maps and bar plots (Fig. 2).

Results and Discussion: Of the 17,120 HiRISE images examined in this study, 5,955 images contain stratified deposits (Fig. 1a, b). Stratified deposits are ubiquitous on Mars, but several regions, including Valles Marineris, Meridiani Terra, Dueteronilus Mensae, and Aeolis Mensae, show a particularly high density of images containing stratified deposits. These high concentrations are likely due, in part, to a sampling bias, although the widespread coverage of images (Fig. 1a) indicates that the distribution of stratified deposits shown in Figure 1b is not solely due to a sampling bias.

Crater interiors and intercrater/canyon plains are the most common and widespread settings in which stratified deposits are found, whereas canyon, channel and chaos deposits are localized to places like Valles Marineris and Nilo Syrtis Mensae (Fig. 1c). As seen in Fig. 2a, craters are the most common setting for stratified deposits in Noachian-aged terrains, canyons are most prominent in Hesperian-aged terrains, and "other" and intercrater/intercanyon plains dominate in Amazonian-aged terrains, most likely due to the presence of volcanic constructs and layered lava plains in these young terrains. An analysis of the global distribution of basin fill vs. wall/uplift deposits in terrains of different ages shows that the proportion of basin-fill deposits decreases in younger-aged terrains, whereas the proportion of wall/uplift deposits remains constant throughout terrains of various age (Fig. 1d, 2b). Although it is acknowledged that the basin-fill deposits need not have a systematic age relationship with the terrains in which they are currently located, the slight skew of basin-fill deposits in older-aged terrains could be representative of a more active sediment cycle during the Noachian and Hesperian periods compared to the Amazonian period. Alternatively, the preferential preservation of older basin-filling deposits could indicate a more active hydrological cycle during Noachian/Hesperian Periods that allowed the lithification and cementation of older deposits.

The analysis of sedimentary rocks on Mars is still in a nascent stage and therefore the process of basic mapping, such as that presented in this study, is critically important. With the widespread coverage and accessibility of high-resolution orbital imagery it is possible to build an objectively-defined stratigraphy for parts of Mars, beginning with the most basic understanding of where and when in the planet's history were certain surface processes and sedimentary depositional environments prevalent. Understanding such broad depositional trends in Mars' past may aid in the eventual stratigraphic correlation of spatially distinct Martian deposits.

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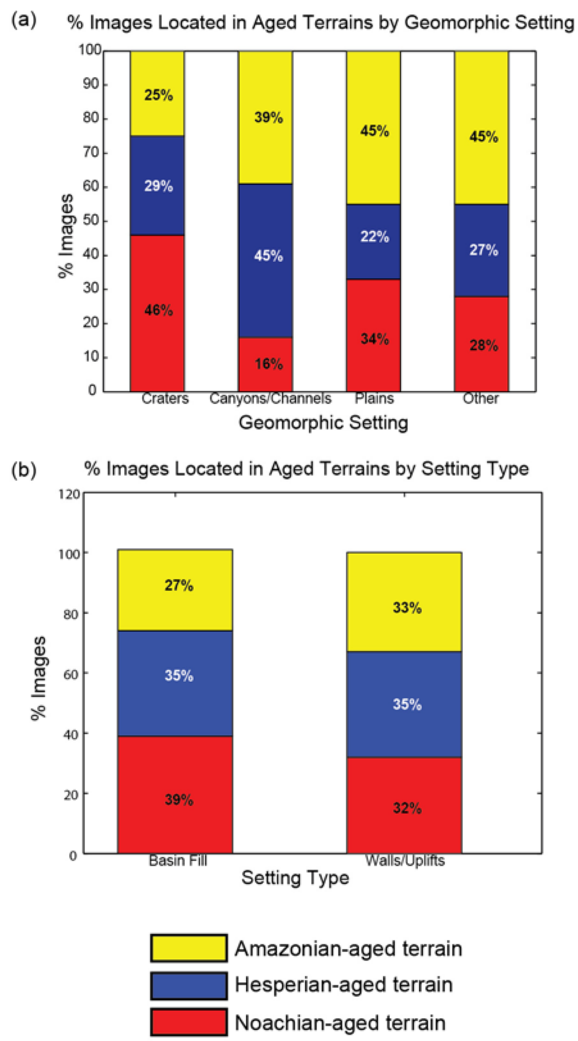

Figure 2. (a) Bar graph showing the percent of images located in Noachian, Hesperian, or Amazonian aged-terrains, grouped by geomorphic setting. (b) Bar graph showing the percent of images located in Noachian, Hesperian, or Amazonian aged-terrains, grouped by setting type (basin fill or wall/uplift).