EARLY HiRISE OBSERVATIONS OF TECTONIC FEATURES. L. Keszthelyi[1], C. Okubo[2], W. L. Jaeger[1], Alfred McEwen[2] and The HiRISE Team, [1]U.S. Geological Survey, Astrogeology Team, 2255 N. Gemini Dr., Flagstaff, AZ 86001, [2]Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721.

Introduction: The crust of Mars records a long and varied history of tectonism. The High Resolution Imaging Science Experiment (HiRISE) camera onboard the Mars Reconnaissance Orbiter provides the opportunity for unprecedented insight into the details of this history. The early HiRISE observations have sampled a range of different types of tectonic features. One important objective was to ascertain what imaging modes are most appropriate for each type of structure and geologic terrain.

Imaging Process: HiRISE observations are chosen from a catalog of suggested targets. In the near future, the tool to add suggestions from the public (HiWeb) will be completed. The suggestions are prioritized by the Science Theme Lead (STL) with assistance from other team members. For the first 3 months of imaging, the prioritization was adjusted to encourage the acquisition of a wide variety of targets without losing the most highly sought observations. Locations where we expected to learn about structural control of groundwater flow were of special interest. Thrity of the suggestions were ranked at the highest priorities. This equals ~5% of the images acquired during this time.

The prioritized suggestions are then used by the uplink group (a HiRISE science team member working alongside a targeting specialist) to select images to command for each 2-week MRO uplink cycle. Because of the layout of groundtracks, conflicts with other spacecraft activities, and/or available downlink, the uplink team did not always select targets in accordance with the STL prioritization.

Initial Results: As of this writing, the first 4 cycles have been completed and 28 observations for which the primary science or secondary science theme was “Tectonic Processes” have been acquired. While the number of acquired images closely matches the 30 suggestions given top priority, we actually acquired only 11 of them. The other 17 were lower priority, but still very valuable, targets. We have successfully imaged (a) extensional, (b) compressional, and (c) strike-slip features in both ancient and young terrains.

Perhaps the single most important early discovery has been fluid-alteration along fractures in some layered deposits [1]. HiRISE color was essential in identifying the alteration.

An unsurprising, but still disappointing, conclusion is that full HiRISE resolution (25-30 cm/pixel) is often not useful for images of structural features in the ancient highlands. The surface is composed of a boulder-rich mantling deposit over heavily cratered bedrock. No layers or other meter-scale features are visible at the surface for kinematic analysis of the local deformation. However, especially given the apparent demise of Mars Global Surveyor and the Mars Orbiter Camera, there is clear value in ~1 m/pixel images, which can be acquired by HiRISE in 4x4 binning mode. Higher binning enables HiRISE to image significantly more area with the available data volume. We expect that the 10-m-scale topography from stereo pairs of such images will place useful constraints on the subsurface orientation and displacement of faults.

HiRISE images of canyons, grabens, and pits that expose lava stratigraphy show promise for correlating layers across lateral distances of kilometers. However, this is complicated by dust and mass-wasting. Furthermore, as on Earth, the lava stratigraphy often is variable on the 100-1000 m scale. In general, 2x2 or even 4x4 binned images appear to be adequate for studies in this kind of terrain.

The sedimentary layered deposits found within canyons and craters have proven to be exceptionally well-exposed. The fresh surface exposure is probably provided by swift erosion, primarily by eolian processes. A variety of features, including joints, angular unconformities, folds, small faults, and marked changes in lithology has already been observed [2,3] (Fig. 1-4). The relatively small number of images acquired to date has not allowed regional deformation histories to be deciphered yet. Still, it is clear that the full capabilities of HiRISE, including color and 1x1 binning, are of great value in these terrains.

Conclusion: The early sampling of a variety of terrains by HiRISE has been invaluable in providing experience for how to most effectively utilize this unprecedented tool for examining the tectonic history of Mars. In older terrain and for regional scale studies, the MRO CTX camera, with 6 m/pixel resolution and a 30 km wide swath, may be more useful than HiRISE. However, the full capabilities of HiRISE are needed to decipher the complex deformation of the layered sedimentary deposits. More quantitative results await the completion of stereo pairs and DEM production [4].

References: [1] Okubo, C. H. and McEwen, A. S. (2007) *Science, 315*, in press. [2] Weitz, C. M. et al. (2007) *LPS XXXVIII*, Abstract. [3] Okubo, C. H. et al. (2007) *LPS XXXVIII*, Abstract. [4] Kirk et al. (2007) *LPS XXXVIII*, Abstract #1482.

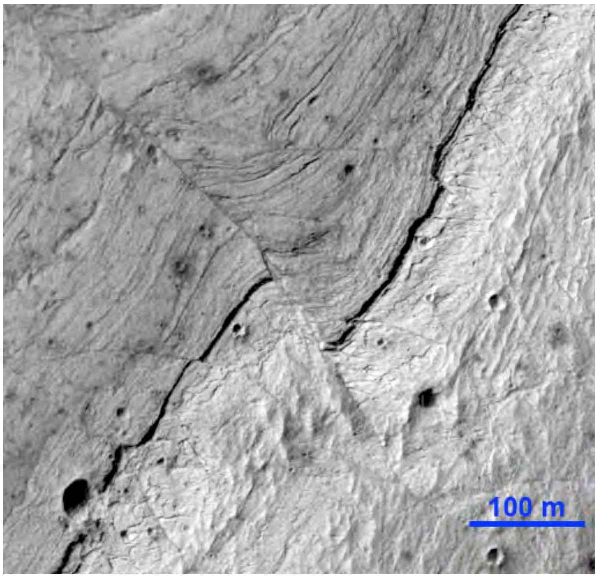

Figure 1. Section of TRA_000823_1720, Ius Chasma. This is the first HiRISE image acquired from the mapping orbit, providing full (26 cm/pixel) resolution. This subscene shows the faulted, folded, and eroded contact between light- and dark-toned layers on the floor of Ius Chasma. The prominent NW-SE break in the rocks is probably a thrust fault that was subsequently tilted and then exposed by erosion. An apparent offset of 70-75 m can be seen on the thrust fault. Drag folds and secondary faults are clearly resolved by HiRISE; offsets as small as 1-1.5 m are resolved in this image. North is up.

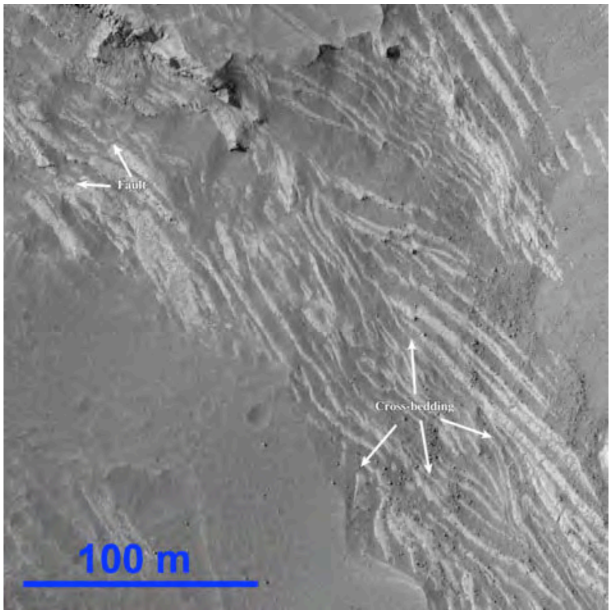

Figure 2. Portion of PSP_001377_1685 showing cross-bedding and a small fault in layered material within Melas Chasma. North is up. See [3] for related quantitative studies.

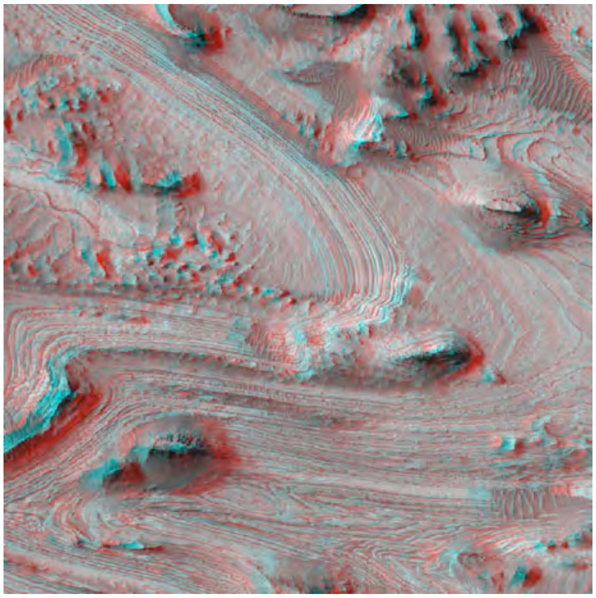

Figure 3. Anaglyph from PSP_1918_1735 and PSP_1984_1735 showing an antiform/synform pair in layered deposits within Candor Chasma. Figure covers 2x2 km with north toward the top. See [2] for addtional discussion of the layered deposits.

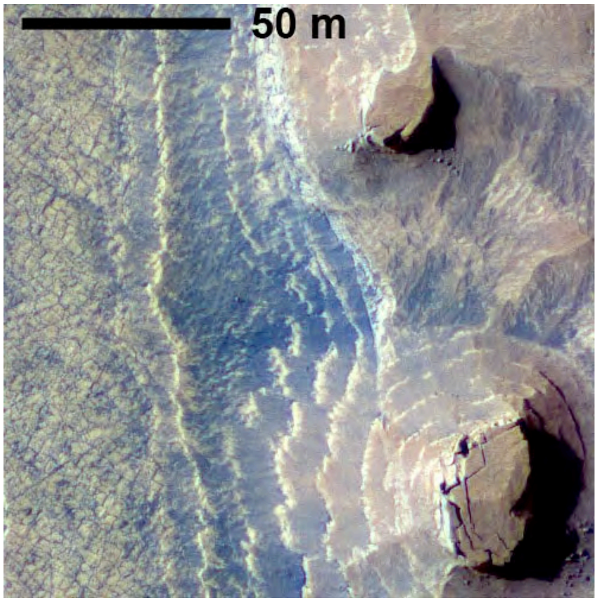

Figure 4. False color subscene from TRA_000873 _2015, showing layered deposits in Bequerel Crater. Color created by combining near-infrared, red, and blue-green channels. Color data is extremely useful for distinguishing between surficial materials and topographic shading in terrain like this. The relatively blue eolian sands accumulate in small fractures, accentuating the joint pattern. The rectilinear jointing indicates a relatively uniform stress field, consistent (but not diagnostic) of only burial and exhumation of the exposed sedimentary stack.