FOR THE PEOPLE: HIRISE DATA PRODUCTS. A. S. McEwen[1], R. Heyd[1], S. Sutton[1], Y. Espinosa[1], A. Fennema[1], R. Leis[1], G. McArthur[1], C. Schaller[1], M. Chojnacki[1], L. Keszthelyi[2], K. Becker[2], R. Kirk[2], E. Eliason[3], [1]LPL, University of Arizona, Tucson AZ 85721 USA (mcewen@lpl.arizona.edu), [2]USGS, Flagstaff, AZ, USA, [3]Home, Flagstaff.

Introduction: The High Resolution Imaging Science Experiment (HiRISE) on Mars Reconnaissance Orbiter (MRO) has been called "The People's Camera" [1]. We proposed, and have carried out, a series of procedures designed to make HiRISE as useful as possible to the science community and general public. These procedures include accepting public image suggestions (/uahirise.org/hiwish). Here we summarize the HiRISE data products [2-10]. As far as we know, HiRISE is the only experiment within NASA's Planetary Science Division that releases high-level PDS products within just 1 to 2 months of acquisition. Furthermore, we have designed these data products for ease of use, including facilitating tools. The success of this approach is demonstrated by the existence of >1000 peer-reviewed science publications using HiRISE data, ~90% from lead authors who are not part of the HiRISE team.

Recipe for Success: The HiRISE data delivery strategy required careful planning starting at the proposal stage followed by consistent prioritization of team resources through all phases of the mission. When HiRISE began operations over 10 years ago, most researchers were working with 32-bit operating systems with a 2 GB file size limit that could not even recognize a large HiRISE image. This required adopting software tools, such as ISIS3 [5-6], that were in an early phase of development. To allow users to view and work with the images without having to download the full image, the JPEG2000 file format was chosen, requiring considerable negotiation with the PDS. The hardware at the HiRISE Operation Center for storing and processing the data required sustained innovation to stay within a reasonable budget and evolve with changing technologies.

HiRISE Data Products and Tools: Data products and tools are summarized in Tables 1 and 2, and Figure 1 provides an illustration of data products for one HiRISE observation with stereo. All products are easily accessed through either PDS or from the HiRISE web site (/uahirise.org). The HiRISE web site also provides a context map, helpful information about the data products, and a link to the HiView page. Captioned images (>20 languages) include additional educational materials such as audio HiClips, slides, wallpaper, and HiFlyers (posters). The Science in Motion webpage highlights recent discoveries.

Recent Improvements: HiRISE data products are described in previous publications [1-4] and online resources (/uahirise.org). There have been some recent improvements. A relatively new Extras data product is the merged (and enhanced) color (Figure 1). Stereo anaglyphs were recently improved to include polar images. Stereo Digital Terrain Models (DTMs) are, as needed, improved by measuring and removing geometric distortions from pointing jitter and other improvements such as autoTriangulation [8, 9]. We have developed procedures to apply FFT processing to remove patterned noise in HiRISE images, which has improved landing site DTMs [10]. All color products will be re-processed in 2016 with improved color registration.

Table 1. HiRISE Data Products

Product	Description
Experimental Data Records (EDRs)	Permanent record of raw data products. Up to 28 products per HiRISE observation.
EDR Extras, including NOMAP products	Reduced-scale browse and thumbnail images. NOMAPS are stitched-together images with radiometric calibration but raw geometry, RED and color (RGB and IRB)
Reduced Data records (RDRs)	Radiometrically-corrected images resampled to a standard map projection at 0.25, 0.5, or 1 m/pixel scale, stored in the JPEG2000 (Joint Photographic Experts Group) format. RED and color versions.
RDR Extras, with merged color	Reduced-scale browse and thumbnail images. Merged color: RED RDR with color in center stripe, typically 0.5 m/pixel, IRB and RGB.
Digital Terrain Models (DTMs)	Elevation values encoded as 32 bit DNs, typically 1.0 or 2.0 m/pixel, with associated orthoimages at original and DTM scales, RED and color.
DTM extras	Shaded relief, color altimetry with shaded relief, browse images, Figure-of-Merit map
Stereo Anaglyphs	Images rotated for stereo viewing with red-green glasses

Table 2. HiRISE Software

Product	Description
HiView	Image viewer for JPEG2000 files, http://www.uahirise.org/hiview
PDS_JP2	conversion to and from standard **Planetary Data System** uncompressed image data files and the new standard PDS/JP2 image data files, uahirise.org/tools/
ISIS-3	Suite of software used to produce HiRISE data products, https://isis.astrogeology.usgs.gov/
JMARS	GIS that integrates HiRISE along with many other Mars datasets, https://jmars.asu.edu/
SOCET SET	Commercial software used to produce DTMs, http://www.geospatialexploitationproducts.com/
Blender	Includes plugin to import HiRISE DTMs in this free, multi-platform, 3D rendering and animation software.

PDS Data Summary: A total of 134.3 TB of HiRISE data resides in PDS as of 1/2016. Table 3 provides a breakdown. There is an average of 292,000 downloads (2.8 TB) per month.

Table 3. PDS Data Product Statistics

Product	Number	Data volume
EDRs	1,082,900	30.4 TB
EDR extras	2,126,255	0.5 TB
RDRs	80,273	35.7 TB
RDR extras	999,813	68.7 TB
DTMs	298	466 GB
DTM extras	6,955	8.0 GB
Stereo anaglyphs	4,506	1.8 TB

References: [1] McEwen, A.S. et al. (2007) JGR, 112, E05S02. [2] Eliason, E.M. et al. (2007) 38th LPSC, #2037. [3] McEwen, A.S. et al. (2010) Icarus, 205, 2-37. [4] Delamere, W.A. et al. (2010) Icarus, 205, 38-52. [5] Keszthelyi, L. et al. (2014) 45th LPSC, #1686. [6] Becker, K. J., et al. (2013) *LPSC* XLIV, #2829. [7] Kirk, R.L. et al. (2008) JGR, 113, E00A24. [8] Sutton, S. et al. (2015) Second Planetary Data Workshop, LPI Contr. 1846, #7056. [9] Kilgallon, A. et al. (2015) 46th LPSC, #2373. [10] Howington-Kruas, E. et al. (2015) 46th LPSC, #2435.

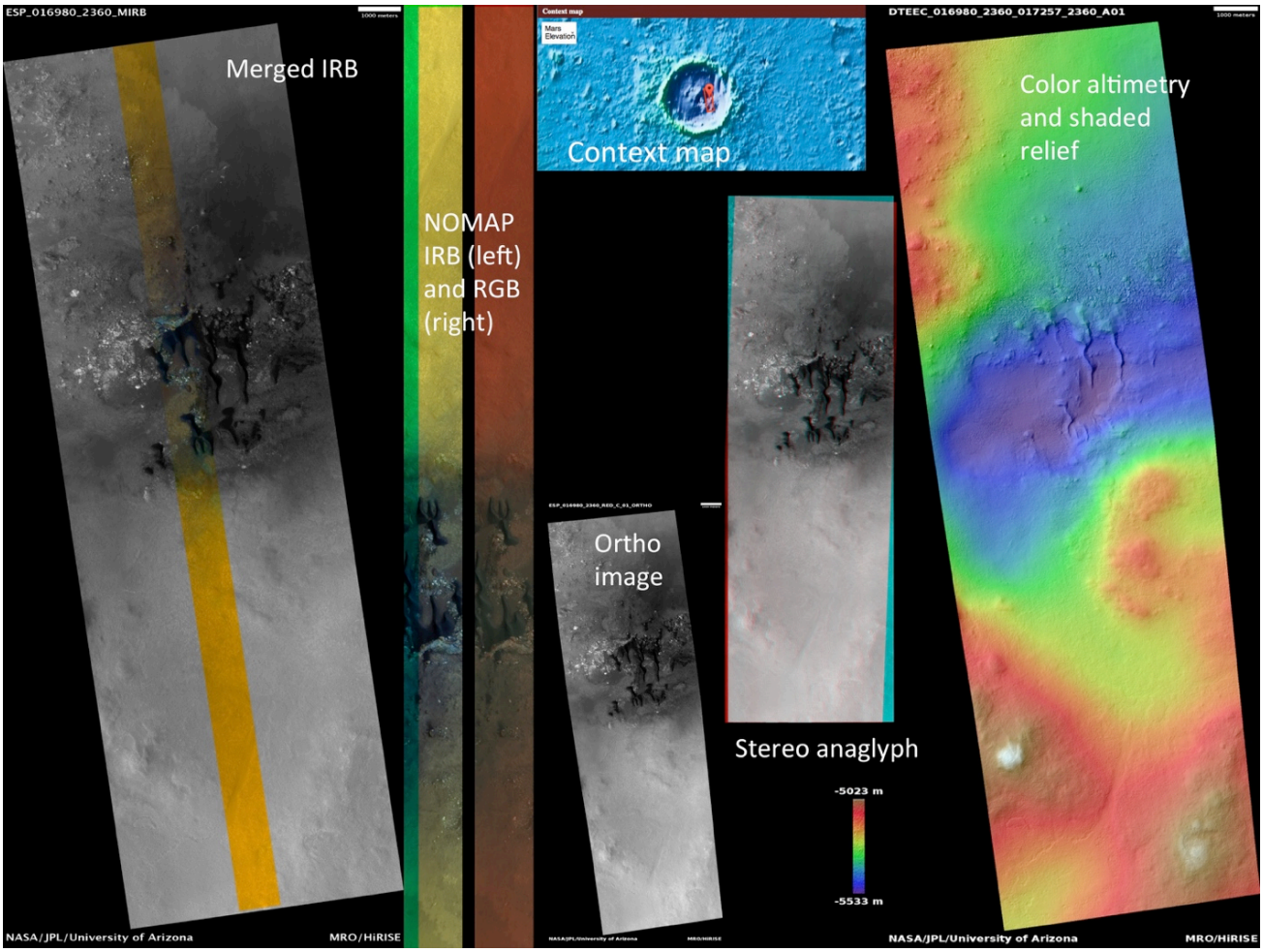

Figure 1: Montage of HiRISE data products for observation ESP_016980_2360, Megabreccia on the floor of Stokes Crater (55.6 N, 171.6 E). From left to right: Map-projected merged RED (grayscale) and IRB (enhanced color); Non map-projected color products (north is down); MOLA elevation showing context for the observations; Orthorectified stereo image; Stereo anaglyph generated automatically prior to DTM production; and map-projected DTM quicklook with color altimetry and shaded relief.
Power to the Pixels!