THE IMAGER FOR MARS PATHFINDER INSURANCE PAN. K. E. Herkenhoff,[1] J. R. Johnson,[1] and L. A. Weller[1], [1]USGS Astrogeology Team, Flagstaff, Arizona (kherkenhoff@usgs.gov).

Introduction: The Imager for Mars Pathfinder (IMP) obtained a full panorama of the Sagan Memorial Station landing site on Sol 2, before the IMP mast was deployed [1]. The images in this panorama were taken in 4 filters (including stereo) and losslessly compressed to provide a high-quality multispectral survey of the landing site even if the IMP mast did not successfully deploy; this data set was therefore called the "Insurance Pan" [2]. It was completed late in the afternoon of Sol 2, just before the IMP mast was (successfully) deployed. The data were stored in memory and returned to Earth after it became clear that downlink rates were higher than expected. The Insurance Pan horizontal (azimuth) coverage is nearly complete, with gaps caused by pointing errors and data packet losses. Stereo data were acquired in the blue (445 nm) filter, as well as right-eye green (531 nm), orange (600 nm), and near-infrared (752 nm) data.

Background and motivation. Previous analyses of IMP multispectral data have primarily made use of multispectral "spots" and the "Super Pan" [3-6], which were taken after the IMP mast was deployed. The multispectral spots were losslessly compressed, 64 × 64 pixel subframes of selected targets. The Super Pan was compressed 2:1 (except for the blue and red stereo filters, which were compressed losslessly), and was 83% complete at the end of mission [2]. The Insurance Pan complements these other data sets by providing high-fidelity (losslessly compressed) image coverage of much of the landing site in 4 filters from a different point of view. The Insurance Pan data can be used for various quantitative studies, including far-field stereogrammetry when paired with images taken after mast deploy. Parts of the Insurance Pan include areas along the photometric equator and are therefore useful in extending previous photometric studies [7]. The potential for these and other types of investigations using the Insurance Pan motivated us to assemble the multispectral mosaics shown below.

Image Processing: Previous attempts to analyze the Insurance Pan have been complicated by the differences in camera pointing between the stereo blue images and the other multispectral images. These differences caused rotation as well as translation of the blue images relative to the other images. The version of the USGS Integrated Software for Imagers and Spectrometers (ISIS) system that was used to process other IMP data [8, 9] included programs to correct for random (but temporary) misalignment of filter bands within an image set acquired with identical camera pointing by translating images relative to each other but not rotating them. Therefore, a new program was developed that performs an affine transformation between Cartesian coordinate systems. This new software was used to register the multispectral bands in the Insurance Pan, as described below.

Radiometric calibration. Version 3 of the IMP calibration algorithm was used to radiometrically calibrate the Insurance Pan images first to radiance and then to reflectance relative using observations of the radiometric calibration target (RCT) [10, 11]. This algorithm compensates to some extent for the temporal and viewing geometry differences between images of the scene and of the RCT, as well as the proportions of direct *vs*. diffuse illumination of the surface, which is a function of topographic slope, viewing azimuth, and time of day. Radiance values of a scene were scale by the ratio of the total downward flux at the time of RCT acquisition to the total downward flux at the time of scene acquisition. This was done by using an approximation to the sky model of [12] to convert the scene brightnesses to values that they would be predicted to have had if observed simultaneously with the RCT images. RCT image sets were acquired four times during acquisition of the Insurance Pan. As such, most scene images were acquired within 30 minutes of RCT images. Because the radiometric precision of the Insurance Pan is not affected by data compression, the radiometric accuracy of the calibrated images is limited only by the camera calibration. The absolute radiometry is therefore accurate to ~10%, and the relative (spectral) radiometry is accurate to ~3% [10, 11].

Registration and projection. Processing of calibrated Insurance Pan images included trimming off invalid pixels from all edges, and locating and replacing dropped compression blocks with null pixel values. Camera pointing and orientation of non-stereo (right-eye) images within a colorset were updated to reflect those values derived for the corresponding triangulated blue-filter stereo image set. A slight change in the camera position between acquisition of imagery through the blue-filter and the other filters within a set required further translational and rotational adjustment of the non-stereo images. ISIS automatically collects control points between any given filter and the corresponding blue-filter (right-eye) image within a set. The addition of manually selected control points was necessitated by the software's difficulty in recognizing common features due to differences in albedo/contrast

between filters and lack of features within bland portions of a scene. A solution for the best fit of control points to an affine transformation was derived to correct for translational and rotational discrepancies. This solution was applied only when an image was projected in order to avoid resampling of the data more than once. Projected, coregistered images were stacked in wavelength-sequential order and placed in an ISIS image cube. All sets for a particular sequence were then mosaicked.

Results: Examples of the Insurance Pan products we have generated are shown in Figures 1 and 2. All of these products were generated using the Macauley-Kirk projection [8]. Preliminary analyses of the Insurance Pan data will be presented at the conference.

Acknowledgments: We thank E. Howington-Kraus, D. Cook, R. Kirk, and K. Becker of the USGS for their work on the IMP control net, cartographic projections, transformations, and coregistration software. The IMP science team was led by Peter Smith at the University of Arizona. This work was supported by the NASA Mars Data Analysis Program.

References:

[1] Golombek M. P. *et al*. (1997) *Science 278,* 1743–1748. [2] Golombek M. P. *et al*. (1999) *J. Geophys. Res. 104,* 8523-8553. [3] Smith P. H. *et al.* (1997) *Science 278*, 1758-1765. [4] McSween H. Y. *et al*. (1999) *J. Geophys. Res. 104*, 8679-8715. [5] Bell J. F. III et al. (2000) *J. Geophys. Res. 105*, 1721-1755. [6] Bell J. F. III *et al*. (2002) *Icarus 158*, 56-71. [7] Johnson J. R. *et al*. (1999) *J. Geophys. Res. 104*, 8809-8830. [8] Gaddis L. R. *et al*. (1999) *J. Geophys. Res. 104*, 8853-8868. [9] Kirk R. L. *et al*. (1999) *J. Geophys. Res. 104*, 8869-8887. [10] Reid R. J. *et al*. (1999) *J. Geophys. Res. 104*, 8907-8926. [11] Johnson J. R. *et al*. (2001) *LPS XXXII,* Abstract #2062. [12] Tomasko M. G. *et al*. (1999) *J. Geophys. Res. 104***,** 8987-9008.

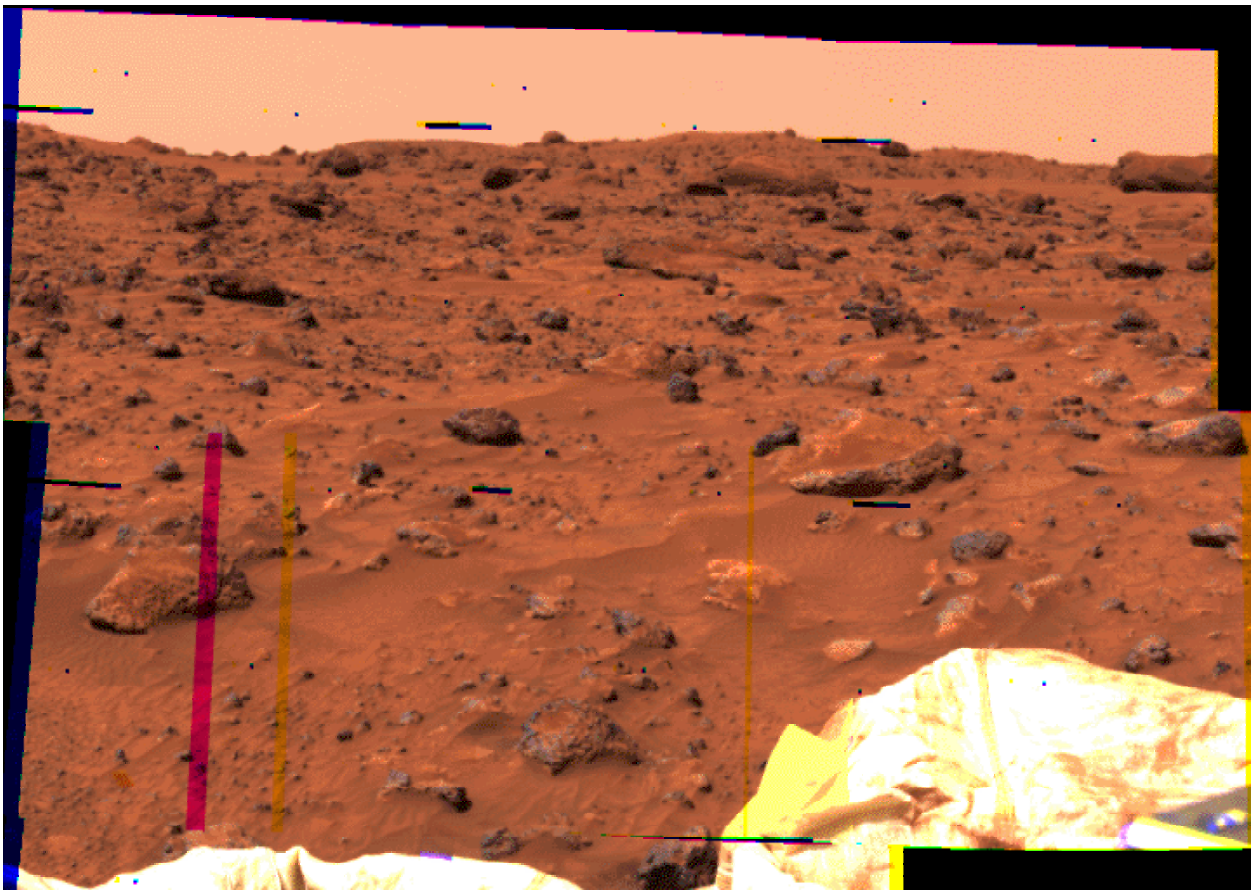

Figure 1. Approximately "true color" rendition of portion of IMP Insurance Pan, azimuth range –10.2 to 32.8 degrees. Red channel = 600 nm, green channel = 531 nm, blue channel = 445 nm. Single black pixels and horizontal black lines are locations of bad pixels that have been nulled out.

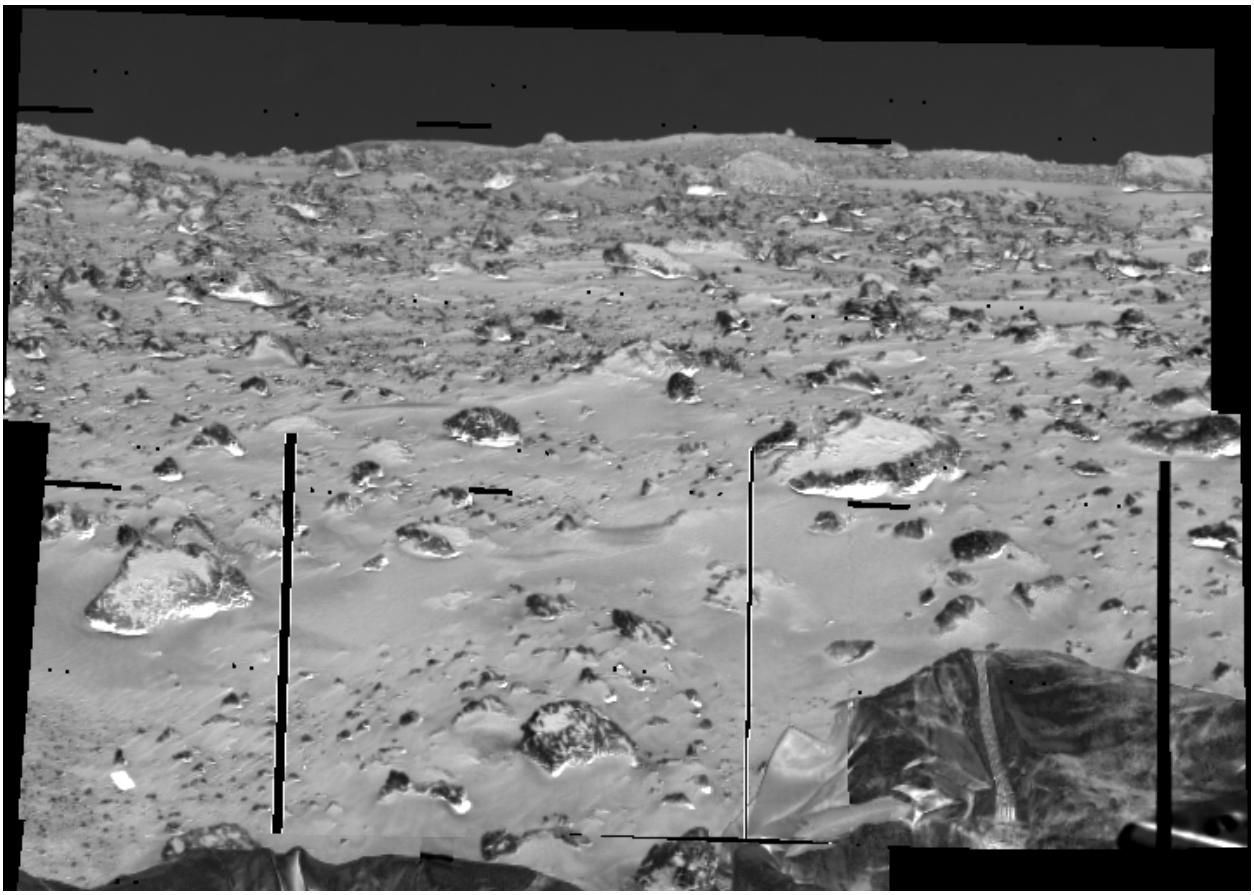

Figure 2. Near-IR/blue ratio image of same portion of IMP Insurance Pan shown in Fig. 1.

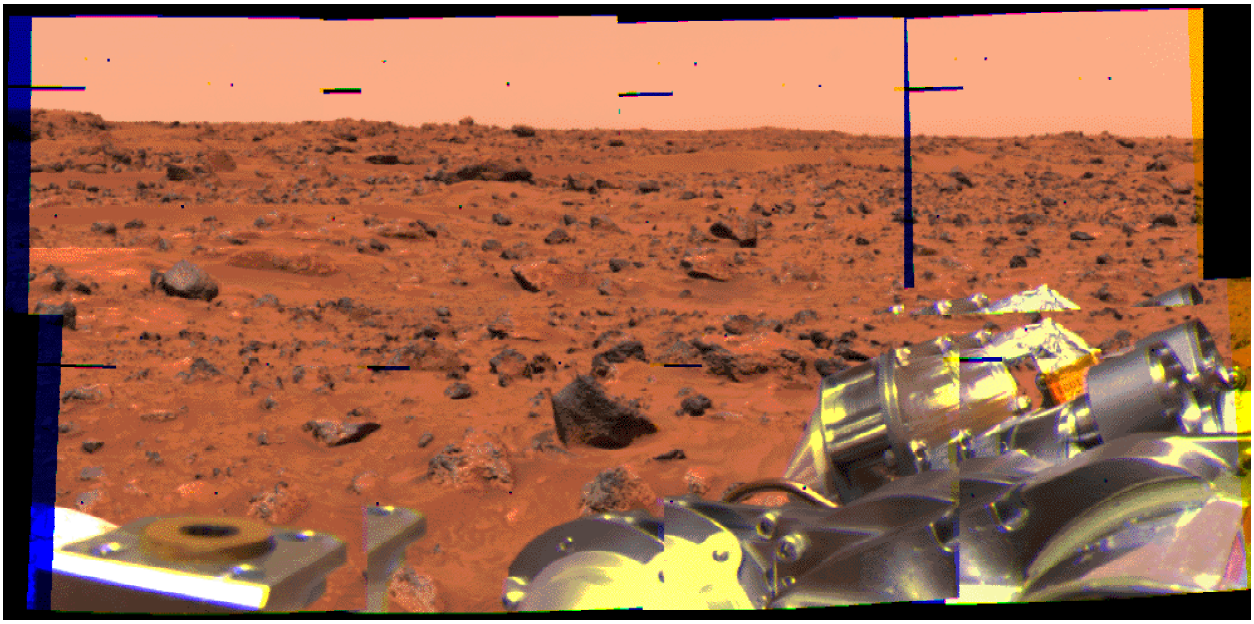

Figure 3. Approximately "true color" rendition of portion of IMP Insurance Pan, azimuth range 32.3 to 89.1 degrees. Red channel = 600 nm, green channel = 531 nm, blue channel = 445 nm. Single black pixels and horizontal black lines are locations of bad pixels that have been nulled out.

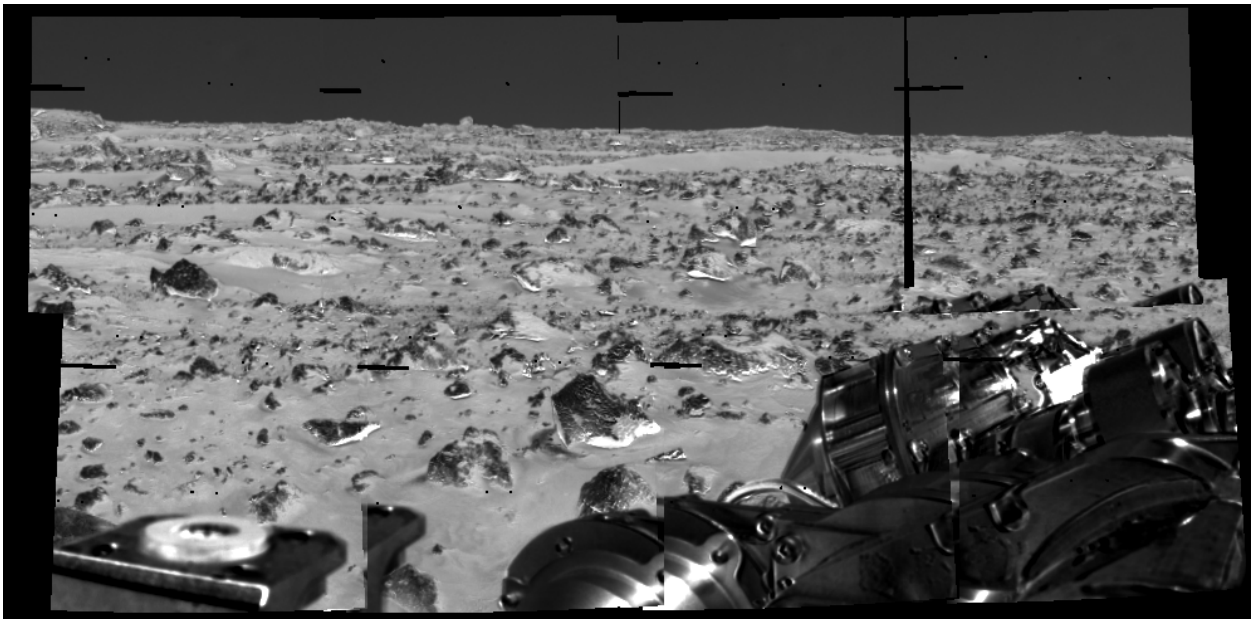

Figure 4. Near-IR/blue ratio image of same portion of IMP Insurance Pan shown in Fig. 3.