DIGITAL RENOVATION OF THE ATLAS OF MARS 1:15,000,000-SCALE GLOBAL GEOLOGIC SERIES MAPS. J. A. Skinner Jr.[1], T. M. Hare[1], and K. L. Tanaka, [1]Astrogeology Team, U.S. Geological Survey, 2255 N. Gemini Dr., Flagstaff, AZ, 86001, (jskinner@usgs.gov).

Introduction. In support of ongoing scientific analysis and in advance of renewed global geologic mapping efforts, we have digitized the Viking-based Atlas of Mars, 1:15,000,000 Geologic Series (AMG) maps (USGS I-1802A-C) originally published in 1986 and 1987 [1-3]. The geologic unit and structural information represented in these hard-copy maps was generated using older Viking image mosaics and drafted on air-brushed, shaded-relief bases, the quality. However, the objectivity and widespread use of the maps as well as the increased use of digital environments for science research establishes a sound need for bringing these maps into a properly-registered and geometrically corrected framework. This abstract outlines the geologic and geometric shortcomings in the existing global maps and details the methodology that we have employed to successfully render the map information without sacrificing pertinent detail of the original work.

Background. The I-1802 maps identified geologic contacts, units, and structures using Viking Orbiter 1:2M-scale photomosaics and individual images, most ranging in resolution from 130 to 300 m/pixel. While today, USGS geologic maps are digitized either during the mapping or production phase, at the time of the I-1802 map production, geologic linework that was originally mapped onto Viking photomosaics was subsequently manually transferred to 1:15M scale airbrushed base maps. Airbrushed maps were also manually produced, using Viking images as guides, and were subject to errors in image position and subjective rendering by airbrush artists. When transferring geologic information, each map author had to estimate the position of geologic features on artistically airbrushed maps even though contacts were originally identified and mapped using high-resolution image frames. After the original linework was inked onto photographic mylar bases, unit coloring was completed using cut-and-peel sticker coatings to produce negatives used for four-color processing.

Shortly after publication, the I-1802 maps were captured into a vectorized digital format using a large Calcomp© digitizing table and software created at the USGS and then converted into a raster format. While this conversion maintained the geologic information, the resolution of the raster file was coarse (~7 km/px). As such, the original vector components of the geologic maps were severely generalized.

In 2000, with the emergence of vector and GIS analysis tools, there was renewed interest in using the original vector files. After more than a decade, however, the original digitized vectors had been lost, leaving the generalized raster map as the sole digital version. This file was "re-vectorized" resulting in the coarsely-located contacts that plague the existing digital version (hereafter referred to AMGv1; Figure 1). Even if the original vector files had been available, the geologic contacts would still not accurately register to any modern Martian digital database as the shaded-relief bases contain kilometers of error from the original pointing information and lack of a tight control network. Due to the significant contact offsets and vector generalization, AMGv1 can only be broadly used for scientific analysis (Figure 1).

Methodology. Our efforts have successfully produced a fully renovated second digital version of the original Atlas of Mars Geologic Series USGS I-maps. The new digital version (hereafter AMGv2) was recompiled in the ArcMap GIS software using a MOLA-derived shaded-relief image [4] and the Mars Digital Image Mosaic 2.1 [5] for registration to the latest Mars control network [6]. AMGv1 was also available within the application but was suitable only as a guide for the new contacts.

Digital environment. The projection for the digital renovation was equidistant (simple) cylindrical centered at 0°N/0°E with an adopted equatorial radius of 3,396.19 km. Longitude of the digitized map increases to the east and latitude is planetocentric as allowed by IAU/IAG (International Astronomical Union/International Association of Geodesy) standards [6] and in accordance with current NASA and U.S. Geological Survey standards.

Geologic contacts. The AMGv2 contacts were digitized by hand at an average scale of ~1:3M. Forgoing automated routines allowed significant quality control and systematic verification of each contact. We transferred lines using a combination of hard-copy map review, analysis of MDIM 2.1, and verification of lines with respect to the MOLA shaded-relief. Because the original published contacts were the result of Viking-based maps, we used MDIM 2.1 as the primary base. Our intent was not to shift lines and reinterpret the geologic map but rather to ensure the proper placement of contacts with regard to the published I-1802 maps. There are areas where a shift in contact inevitably occurred. It was generally apparent what feature or characteristic the original author used in Viking imagery to delineate a contact. Oftentimes, these surface characteristics did not spatially match with MOLA topography. As such, we remained as true as possible to the author's original

intent. Structure was digitized at equivalent scales and parameters with the same sensitivity to preservation of original detail as the geologic contacts. The addition of structure is a notable addition over the AMGv1, which does not include any structural linework.

Data format. The file will be released as a USGS Digital Series publication in decimal degrees using the ESRI shapefile vector format. We will also release the vector files in the open standard GML (Geographic Markup Language) format as well as create a raster version for image-based software packages. Metadata, which is digitally integrated dataset documentation (e.g., unit descriptions, geologic history), is required by the Federal Geographic Data Committee (FGDC) and will be included in released data.

Results. The renovation of the 1:15M scale Viking-based geologic maps provides the scientific community with a digital version of global-scale geologic maps. These will provide significant utility for a host of planetary studies. For example, web-based Mars Crater Density Tools [8] will use the AMGv2 contacts in order to acquire crater statistics based on accurate extents of surface units. A significant problem with relying on the AMGv1 contacts for local to regional crater statistics was that geodetic offsets meant that craters from adjacent geologic units were commonly gathered inappropriately for statistics. Detailed unit placement improves the calculated areas and gathers only those craters that reside within the unit boundary. Additionally, with the completion of a MOLA and THEMIS-based global crater database, the AMGv2 can be used to reassess global stratigraphy in advance of renewed geologic mapping efforts.

We will have the AMGv2 renovations completed, edited, and available for distribution by March 2006. The digital versions of these and other geologic maps will be available for view and download at the PIGWAD [7] website (http://webgis.wr.usgs.gov/).

References. [1] Scott and Tanaka (1986) *USGS I-1802-A*, 1:15M scale. [2] Greeley and Guest (1987) *USGS I-1802-B*, 1:15M scale. [3] Tanaka and Scott (1987) *USGS I-1802-C*, 1:15M scale. [4] Smith et al. (2003) MEGDR. NASA PDS. [4] Archinal et al. (2003) MDIM 2.1 *ISPRS WG IV/9*. [6] Seidelmann et al. (2002) *Celest. Mech. Dyn. Astron*, 82, 83-110. [7] Hare and Tanaka (2004), *LPSC XXXV*, Abstract #1765. [8] Hare and Tanaka (*this volume*).

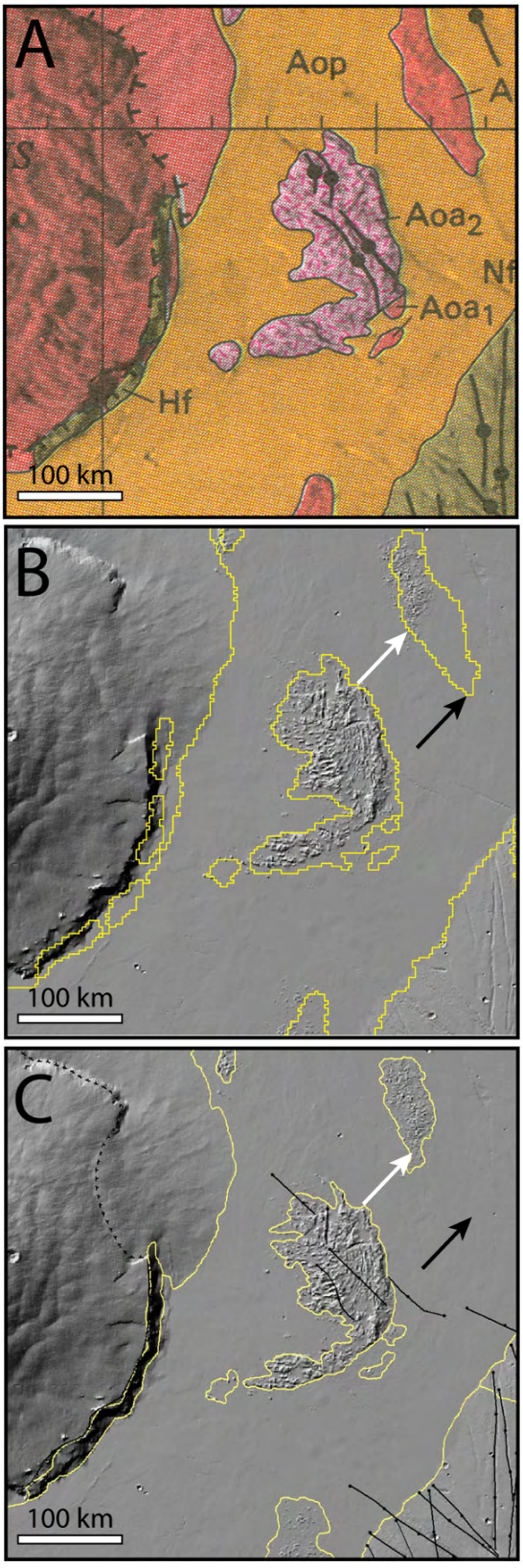

Figure 1. *(right)* A comparison of the originally published 1:15M scale geologic map (A), existing digital AMGv1 (B), and the renovated AMGv2 (C). Note the 'rasterized' appearance of the geologic contacts in B as well as the ~80 km difference between the old contacts (black arrows) and the new contacts (white arrows). Figure is presented at ~1:7.5M scale.