MERGING OF THE USGS ATLAS OF MERCURY 1:5,000,000 GEOLOGIC SERIES. A. Frigeri[1], C. Federico[1], C. Pauselli[1], A. Coradini[2], [1]Geologia Strutturale e Geofisica, Dipartimento di Scienze della Terra, Universita degli Studi di Perugia, I-06126, Perugia, Italy (afrigeri@unipg.it), [2]Istituto di Fisica dello Spazio Interplanetario - INAF, Roma, Italy.

Introduction: After 30 years, the planet Mercury is going to give us new information. The NASA MESSENGER [1] already made its first successful flyby on December 2007 while the European Space Agency and the Japanese Space Agency ISAS/JAXA are preparing the upcoming mission BepiColombo [2].

In order to contribute to current and future analyses on the geology of Mercury, we have started to work on the production of a single digital geologic map of Mercury derived from the merging process of the geologic maps of the Atlas of Mercury, produced by the United States Geological Survey, based on Mariner 10 data.

The aim of this work is to merge the nine maps so that the final product reflects as much as possible the original work. Herein we describe the data we used, the working environment and the steps made for producing the final map.

Original data: The USGS Atlas of Mercury 1:5,000,000 Geologic Series is a group of nine maps produced by various authors between 1980 and 1990 (see Table 1). In 2000 these maps were converted by USGS to a digital vector interchange format suitable to be used with Geographic Information Systems (GIS). The data as well as metadata are available for download from the USGS PIGWAD server (http://webgis.wr.usgs.gov/).

I. no	Quad.	Authors	Year
I-1660	H-1	Grolier, Boyce	1984
I-1409	H-2	McGill, King	1983
I-1408	H-3	Guest, Greeley	1983
I-1233	H-6	De Hon, Scott, Underwood	1981
I-2048	H-7	King, Scott	1990
I-1199	H-8	Schaber, McCauley	1980
I-1659	H-12	Spudis, Prosser	1984
I-1658	H-11	Trask, Dzurisin	1984
I-2015	H-15	Strom, Malin, Leake	1990

Table 1: 1:5,000,000 Geologic Maps of Mercury published by USGS up to 1990.

The working environment: The working environment was set up on a GNU/Linux based workstation with ISIS and GRASS GIS software installed on it. The Geographic Resources Analysis Support System (GRASS), originally developed by the U.S. Army Construction Engineering Research Laboratories between the 1980s and the 1990s, is a complete suite for the processing of spatially referenced data and now is released as a Free Open Source Software and maintained by an international team of developers [3]. Since 2007 GRASS GIS supports reading PDS and ISIS data using the Geographic Data Abstraction Library (GDAL). Besides this feature, GDAL also offers import/export to almost every digital raster map format. In the first years of development GRASS was known mainly for its raster processing capabilities. Since version 5.0, it now offers a new vector engine which allows the user to process vector data more efficiently. As with GDAL, a specialized library called OGR Simple Features Library guarantees importing and exporting vector data in a wide range of formats.

The merging process: The nine digital geologic maps have been imported into the GRASS GIS database, in Cylindrical projection, using a planetary radius of 2439 km.

The three distinct information layers available are: 1) the geologic units, 2) the structures and 3) a miscellaneous layer which consists of albedo features, mostly associated with craters. To support the editing process we also imported the scan of the USGS I-1149 shaded relief map to provide an overview of the morphology where required.

We first started to work on the geologic units, which require particular care as topological integrity has to be maintained throughout the merging process. First of all we verified that tabular information linked to the geometrical objects was coherent, so that the same geologic unit was going to be identified by the same code in all the maps. Then, after trimming the extension of every single map, we started the merging process by editing boundaries shared by pairs of maps. The overall consistency of the geometry of the geologic contacts on the boundaries of the maps is good apart from a subtle shift due to the interpretation process.

In the editing process, however, we have found two main families of mismatches along the maps' boundaries. There are areas that show geologic units on one side that are not present on the other side. In other zones, the units are detected on both maps and contacts coincide on the boundaries, but the areas are assigned to different geologic units. At this stage of the work we decided to maintain intact the coherence of the original data, without applying any kind of interpretation. All the editing operations have been done just to solve the topological problems of the map that arose in the subsequent merging phases.

The colors of the geologic units were sampled

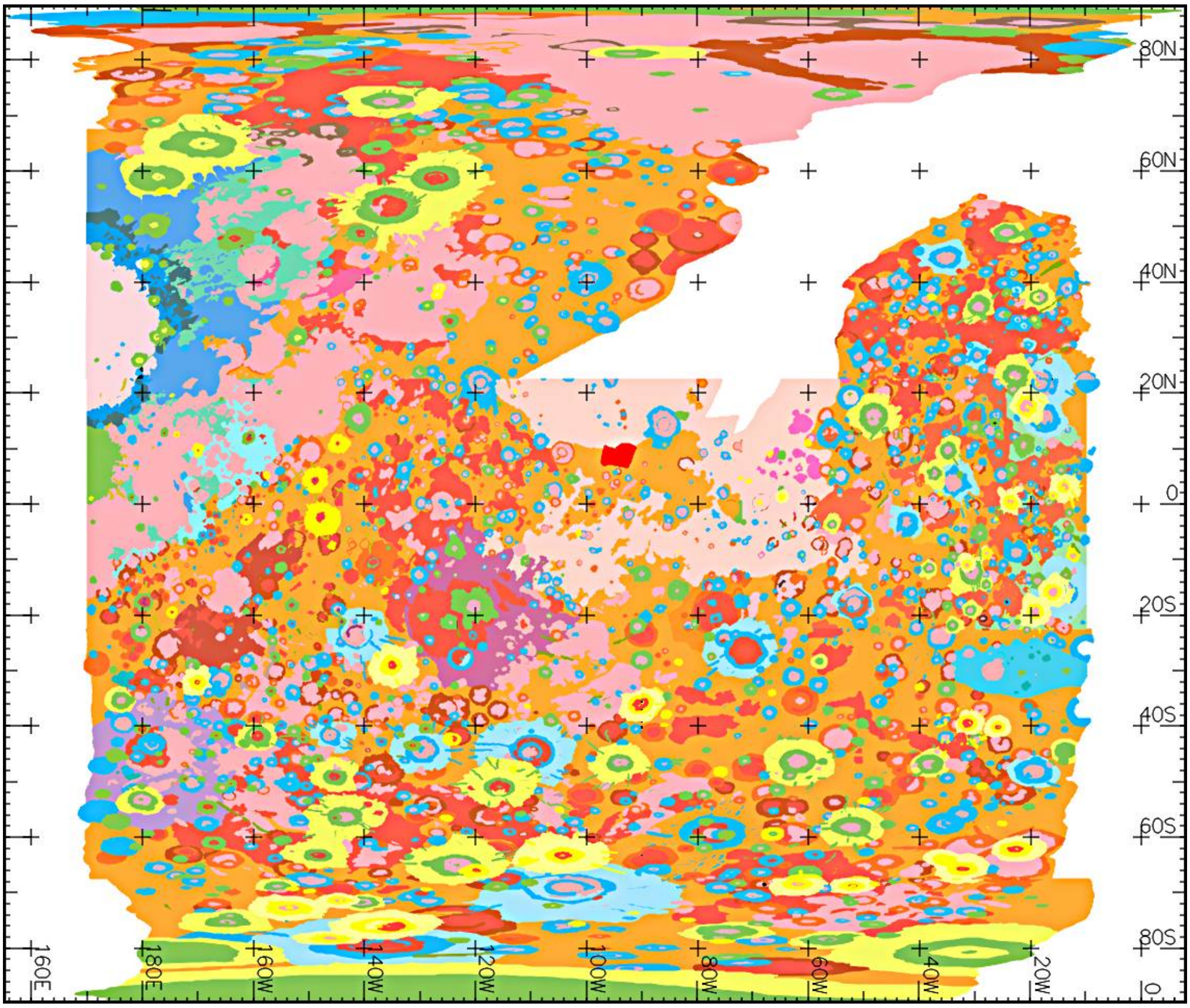

Figure 1: The geologic information of the nine maps of the 1:5,000,000 Atlas of Mercury series, merged in a single map and displayed in GRASS GIS in Simple Cylindrical projection; the color scheme follows the original authors' work (Table 1).

Results and Discussion: Figure 1 shows the complete geologic map in its full extent.

A single digital geologic map of Mercury has several advantages. The analyses of zones that before were falling among two, three or four quadrangles is much simplified and a cleaner overview of the geologic setting is now possible. The features of the complete map can be quickly queried in a single step. Single map ingestion on web based mapping services is much simpler.

As MESSENGER and BepiColombo will send more detailed and accurate data than Mariner 10, it will be possible to perform a renewal process of the geologic map both by filling unmapped areas and by improving the accuracy and resolution of mapped units, as done for example by Skinner et al. [4] who have updated the geologic map of Mars, originally based on Viking data, with a newer and more accurate one delivered by recent missions.

With the upcoming release of the first MESSENGER data on the Planetary Data System (planned on July 15th, 2008), newer imagery of both mapped and unmapped areas of Mercury [5] can be overlaid on the geologic map to detect common features, differences and to observe new details.

References: [1] Solomon S. C. et al. (2007), *Space Sci. Rev., 131*, 3-39. [2] Benkhoff J. and Schulz R. (2006), *Adv. Geosci.*, *3,* 51-62. [3] Neteler M. and Mitasova E. (2008), *Open Source GIS: A GRASS GIS Approach. Third Edition.* [4] Skinner J. A. et al. (2006), *LPSC XXXVII*, abstract #2331. [5] Prockter L. M. et al. (2008), *LPSC XXXIX,* abstract #1211.